Thesis/
Reports
Toepfer,
J.

WINTER HABITAT USE BY GREATER PRARIE CHICKENS IN THE SHEYENNE NATIONAL FOREST GRASSLANDS, NORTH DAKOTA

John Toepfer & Robert L. Eng

WINTER HABITAT USE BY GREATER PRAIRIE CHICKENS ON THE SHEYENNE NATIONAL GRASSLANDS NORTH DAKOTA, 1984-85

PHASE II

John Toepfer

Robert L. Eng

Cooperative Study between:

Rocky Mountain Forest and Range Experiment Station

U.S. Forest Service

Rapid City, South Dakota

and

Fish and Wildlife Program

Montana State University

Bozeman, Montana

Agreement No. 28-C2-204

INTRODUCTION

Since the 1960's, winter ecology of the greater prairie chicken (Typanuchus cupido) has been largely ignored. Recent studies have emphasized spring and summer ecology concentrating on nesting and brood rearing habitat. Past studies that deal with winter were limited with regard to movements and habitat use (Schmidt 1936, Grange 1948, Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al. 1957, Robel et al. 1970 and Horak 1985).

Recent studies on the Sheyenne National Grasslands (SNG) have also emphasized nesting and brood rearing habitat. A general overview of the seasonal habitat use by prairie chickens was provided by Manske and Barker (1981), but the data are limited with regard to the critical winter habitat components. This study was initiated to improve the understanding of the winter ecology of the greater prairie chicken on the SNG and to explore the effects of grazing practices on winter habitat used by prairie chickens in the northern midwest.

This study, conducted during the winter of, 1984-85, was a continuation of a nesting and brood rearing habitat study conducted during spring and summers of 1983 and 1984. Radioed hens were monitored until they began incubation and although this information was not within the scope of the winter study, the spring locations provided movement patterns from winter to spring. Nesting habitat for these hens was incorporated into the nesting phase of this study (Phase I).

We gratefully acknowledge the following: Robert Riddle, William Fortune and Mike McNeal of the U.S. Forest Service, Lisbon, North Dakota for their cooperation and logistical support, and Mark Rumble, U.S. Forest Service, Rapid City, South Dakota for administrative support through both phases of the study; the North Dakota Game and Fish Department for generously providing a vehible throughout the winter phase of the study; and finally Joe Milton, members of the Sheyenne Valley Grazing Association and residents of the area, whose acceptance of and cooperation with the field activities, not only contributed considerably toward the completion of this study but made working in the area much more enjoyable.

STUDY AREA

The Sheyenne National Grasslands (SNG) is located in south eastern North Dakota approximately 32 km (20 miles) east of Lisbon and 36 km (22 miles) southwest of Fargo. The small town of McLeod is situated near the center of the area. The elevation is 328 m (1075 ft). The north unit of the SNG contains within it's boundary 52,837 ha (130,558 acres) of which 48.4 % is private and 51.6 % is public land managed by the U. S. Forest Service (USFS) in association with the Sheyenne Valley Grazing Association (SVGA), (Fig. 1).

The terrain is varied from level to rolling tree-covered hills referred to locally as sandhills. The area is relatively open, but dotted with scattered solitary trees and small clumps of cottonwood (*Populus deltoides*), aspen (*Populus* spp.) and oak (*Quercus* spp.). Shelterbelts typically surround houses and frequently line the borders of agricultural fields. The grass areas vary from level to rolling with grass-covered sand dunes 1.5 to 3 meters (m) (5-10 ft) above the level lowlands, which vermiculate between and through the higher uplands. Manske (1980) divided the grasslands into three major communities: Upland (mixed grass prairie) dominated by blue gramma (*Bouteloua gracilis*), and Kentucky blue grass (*Poa pratensis*); Midland (tall grass prairie) dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium*

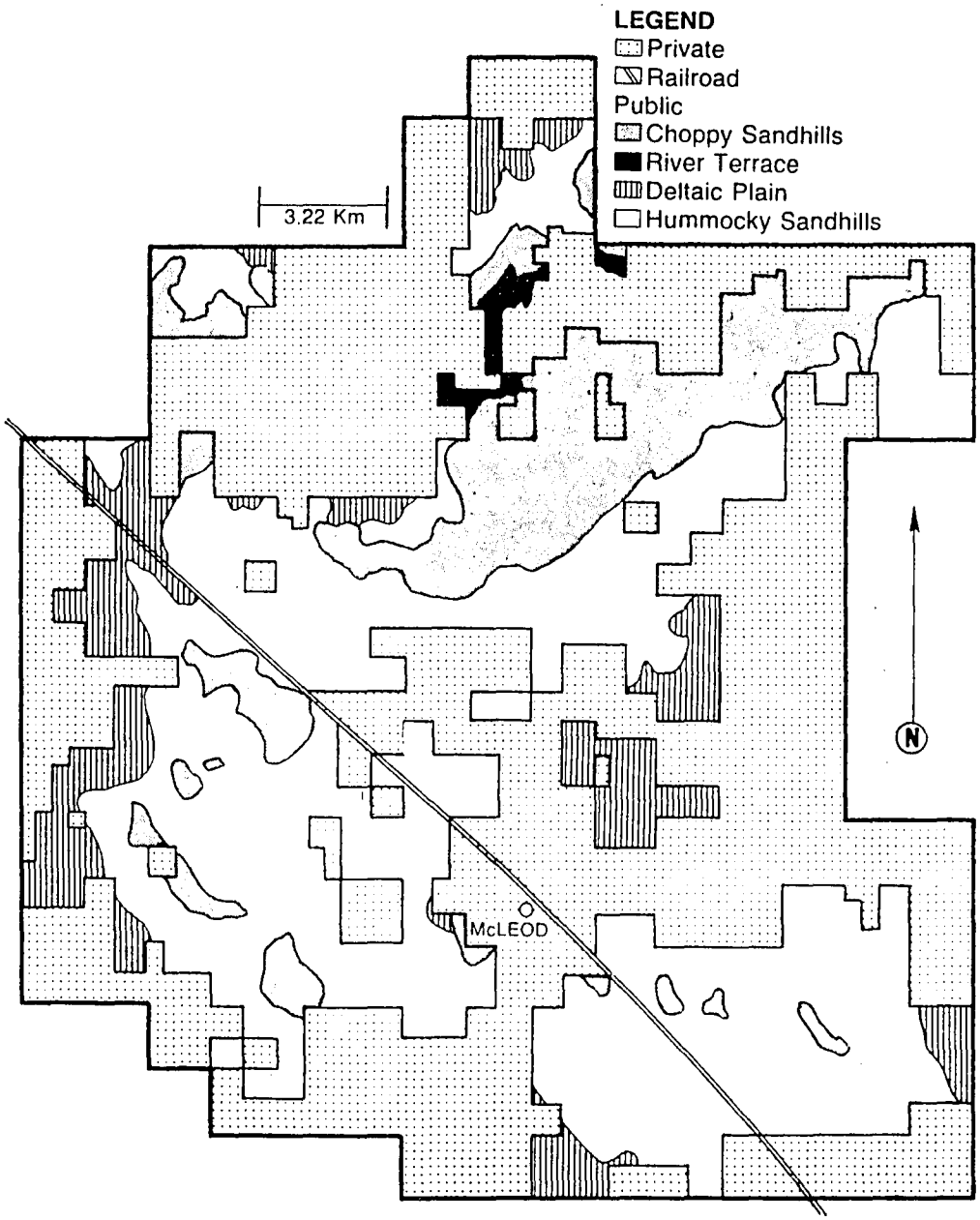

Fig. 1. The north unit of Sheyenne National Grasslands (cover type units adapted from Manske 1981).

scoparium), and Kentucky blue grass and switchgrass (Panicum virgatum); Lowland (sedge meadow) dominated by sedge (Carex spp. and Carex lanuginosa), Kentucky blue grass, Reed grass (Calamogrostis inexpansa) and switchgrass. The upland areas were in places dominated by thick patches of snowberry (Symphoricarpos occidentalis) and Kentucky blue grass. Private land was used primarily for cash crops, such as corn (picked and silage), sunflowers, soybeans and alfalfa for hay. Cattle were pastured in the harvested corn fields during the late fall until the snow became too deep. Private grasslands were managed for prairie hay (mowed in July) and were typically grazed after mowing.

The SNG is managed using a multiple pasture system (1,2,3 or 4 pastures), primarily 3 pasture units. All 2, 3 or 4 pastures are grazed at least once during the period May to November. One of the 3 or 4 pastures is usually deferred during the peak of the growing season. Single pastures are grazed continuously throughout or for only part of the grazing season. The length depends upon the size of the pasture, type of cattle and condition of pasture. Most level lowlands are mowed once every 3 years to stimulate regrowth and encourage cattle to graze the lowlands. Vegetation mowed in the lowlands is used for winter feed. Water is provided by windmills or dugouts located within pastures or in paddocks between pastures. Areas left undisturbed are the tree cover, blowouts and lowland areas too rough to mow. As a management

tool burning is not used on a regular basis. Alfalfa is mowed 2 or 3 times during the growing season.

According to Joe Milton, a life-long resident of the area, prairie chickens and sharptails have been present on the grasslands for at least the past 70 years. Recently the prairie chicken reached a peak of 420 cocks in 1979 (Fig. 2.). The past three years the population has declined from 400 to 260 cocks. The exact reason(s) for this decline is not known, but drought and several tough winters have been associated with the drop in numbers. Sharptail numbers are lower than prairie chickens, but censuses of this this species have not been as thorough.

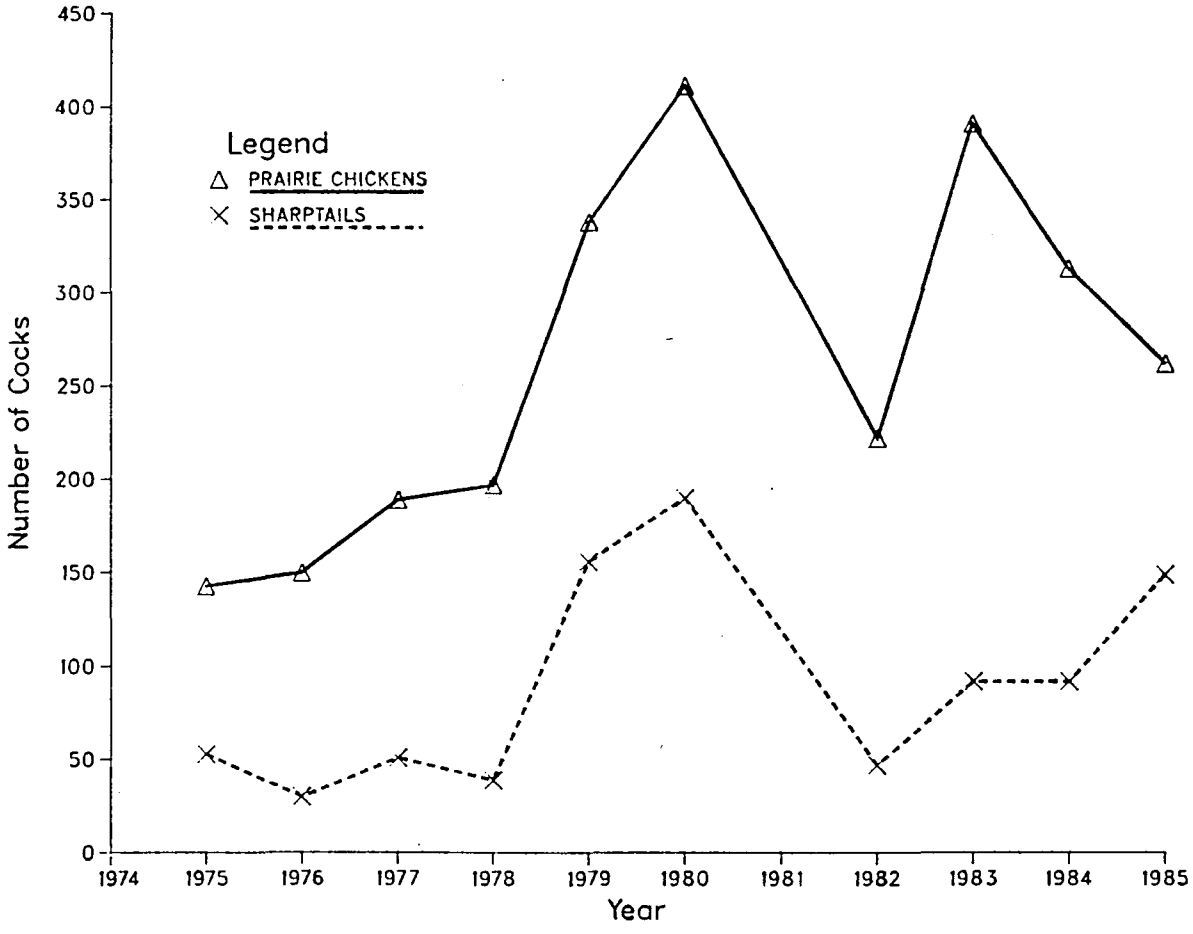

Fig. 2. Prairie grouse display ground counts on the Sheyenne National Grasslands, 1975-1985.

METHODS

Weather

Maximum and minimum temperatures and depth of snow were recorded daily. Supplemental observations were made in the field regarding wind and snow conditions. Official precipitation records were obtained from the U. S. Weather station 2 miles east of McLeod.

Trapping

Prairie chickens and sharptails were captured in traps constructed of lengths of welded wire (approximately 0.7 X 3 m) with 2.5 cm mesh. The wire was staked to the ground in a circle forming a funnel on one side and covered with fish netting. Three to five traps were placed in known feeding areas and baited with cobbed corn. Traps were watched or checked hourly during the AM and PM feeding periods. Traps were closed and the bait removed when they were not monitored. The age, adult or immature, was determined by primary feather molt and wear (Petrides 1942, Wright and Hiatt 1943, and Ammann 1944) and by depth of the bursa (Gower 1939, and Kirkpatrick 1944).

Radio Telemetry

Radio transmitters (SM1 Type and SB2, AVM Instrument Company, Dublin, California) were in the 150-151MHz frequency range. Transmitters were powered by solar panels connected to a NiCad battery that stored power to run the

transmitter for 4 to 36 days without light. The units were attached to the bird using a bib system similar to that used by Armstrup (1980). Weights of the units varied from 12 to 16 g for the SM1's (1.5-1.9% body weight) and from 19 to 22 g (1.9-2.6%) for the SB2 units. The latter units had a reduced whip antenna (16 cm) to prevent the antennas from slapping the bird's wings as they flew. The smaller units had full length antennas (25 cm) pointed forward and held at a 45 degree angle by a spring to avoid wing slapping (Toepfer and Newell unpubl. data) Two birds were radioed with back pack units (Dumke and Pils, 1973) that weighed 27 g or 3.0 % of the birds body weight.

Radioed birds were located by triangulation with an AVM, LA12 continuous band receiver connected to a single 3.4 m high, 8-element (Hy-Gain) yagi antenna mounted on a vehicle. Ground to ground range of the system was .8 km and 1.6 km for the smaller and larger radios respectively. Triangulation lines were taken from known locations observable on aerial photographs (junction roads, driveways, fencelines). The orientation of the vehicle to obtain a baseline for the signal line was accomplished by lining the antenna on or along a known point or line (fenceline, road, windmill, farm lights at night) Average accuracy using signal nulls for known transmitter locations (night roosting birds) with angles of intersection of between 60 and 120 degrees was 27.8 m (N = 78, SD = 15.4) from 262 to 1016 m (Mean = 479.8, SD = 189.2). When locating a radio-tagged bird, efforts were made to approach

within 500 m and keep the triangulation angle as close to 90 degrees as possible to improve location accuracy (Heezen and Tester 1967). Greater signal strength of the larger radio resulted in longer triangulation lines. Lines of over 1600 m were avoided, but when used, a third line was added and the middle of the enclosed triangle was assumed to be the location of the bird. To reduce error due to movement during the day, sets of triangulation lines were used only if they were taken within 5 minutes of each other. At night, birds were located by approaching with a vehicle to within 5 to 20 meters, marking the line and returning the next day to locate the roosts for detailed analysis. A 3-element hand held antenna was used to find individuals at close range and recover dead birds. Radio-tagged birds that could not be located on the ground were located with an airplane using a receiver, switch box and a 3-element antenna clamped to each wing strut. Ground to air range at an altitude of 1000 m was 5.6 km and 10 km respecively for the small and large transmitter types. Airplane locations were verified with the ground equipment. An effort was made to locate each radio-tagged bird at least once a day and once at night.

All radio locations were plotted on acetate overlays of aerial photographs (Scale, 1:660). Each location was classified as to the date, time (CST), straight line distance to the last location, distance to the nearest booming ground, home or regular booming ground, nearest sharptail dancing

ground, the type of movement, habitat, disturbance type, height class and activity. When two or more locations were obtained per day one was randomly selected to calculate the distance between consecutive daily locations (Robel et al. 1970a). The distances between locations were stratified into 3 types of daily movements: (1) the distances between a daytime and a subsequent night location (daylight to night move) (2) distance between consecutive night locations, and (3) distances between consecutive daily locations. The distance to the nest was measured to the first known nest. The home booming ground for cocks was the one on which they displayed and for hens it was the one nearest their first nest.

Home Range

Radio locations were digitized into an X and Y coordinate system using the Universial Transverse Mercator Grid (UTM) (Avery 1977). In this format the locations were entered into a computer program TELDAY (Lonner et al. 1983) to determine home range area. Home range is that defined by Burt (1953) and its area calculated by enclosing the outer perimeter (Hayne 1949).

Habitat Use

Habitat types used by radioed birds were classified using cover type maps of the areas used by radioed birds drawn on aerial photographs. Ocular percentage estimates were used to place cover into 7 general habitat categories: Grass, Forbs, Agricultural, Shrubs, Wetland, Trees, and Other. Paired

combinations of these categories i.e. Grass 80-100 % equaled Grass, whereas a mixture of 50-75 % Grass and 25-50 % Forbs equaled Grass/Forbs. A shift in composition favoring Forbs (greater than 50 %) was classified as Forbs/Grass habitat. These general categories were then visually classified according to the dominant plant specie(s). Disturbances were classified as to the type of disturbance within the last 6 months (undisturbed, agricultural, grazed, mowed). The type of pasture system was one (continuous) or two, three, or four pastures. Each pasture was either grazed during the growing season (nondeferred) or not grazed (deferred). Vegetation height classes were established relative to the height of a standing prairie chicken. Class I up to the belly of a bird (0-8 cm), Class II up to the eye of a bird (9-25 cm), Class III above the birds head (26-50 cm), Class IV (51-100 cm) Class V (1-2 m) and Class VI (over 2 m). These classes were applied to the predominant screening level of the cover. In most cases this was the maximum screening height of the vegetation. In instances where two classes were together in a mosaic pattern, the stand was assigned to the dominant form. Class III vegetation with patches of Class I were classified as III. In addition to the major categories, habitat, disturbances and height were classified as an edge type when a location was within 55 m (the distance of 95% accurracy) of a different habitat or disturbance. This compensated for the limitations in the accuracy of the radio locations and reduced the

possibility of placing the location in the wrong habitat type.

Night Roost Analysis

Night roosts were differentiated from day roosts by the number of droppings (day roosts 5 or less). The following data were collected at each roost: Robel pole (Robel et al. 1970b), snow depth, last disturbance, height class, distance nearest roost, maximum distance between roosts, depth of roost in snow, distance to nearest edge, type and disturbance of edge, and distance to feeding area. Random measurements were taken at points one meter apart along a line parallel to where the birds roosted.

Other

Winter was that period when 7 cm of snow had accumulated covering most ground level foods (15 December to 17 February) and early spring the period after the snow was gone (18 February to 15 March). In addition to the winter period data were stratified into weekly periods,

The day was divided into two periods, daylight and dark. Daylight hours were stratified into 3 equal periods (AM, MIDDAY, PM) begining 1 hour before sunrise and ending 1 hour after sunset.

All prairie chicken observations were placed in one of six categories: feeding, displaying, day roosting, night roosting, flying, and budding. Fecal droppings were collected from a number of individual roosts for future food habits analysis.

All information collected was computerized and analyzed using SPSSX (Statistical Package for Social Science) (Nie et al. 1983). P values are presented in parentheses.

We emphasize that statistical or mathematical differences may or may not be biologically significant. They are only guides to possible differences and should be treated as such. Our personal observations of prairie grouse suggest that they exist within ranges limited by their general biological and physiological capabilities, individual experiences, and conditions at a given point in time. In other words though it may be true mathematically, biologically there is probably no such thing as an average prairie chicken. Therefore we have chosen to identify common trends and patterns from which management decisions can be made.

Scientific names of birds are based on the Sixth edition of the American Ornithologists' Union Check-list of North American birds (1983). Plant and mammal names are after Gleason and Cronquist (1963) and Honacki et al. (1982) respectively.

RESULTS AND DISCUSSION

Weather

The winter of 1984-85 on the SNG can best be described as having average temperatures, below normal snowfall and an early spring. Mean temperature for winter was 3.9F (SD = 12.3) and ranged from - 29 to 33. At times the wind chill factor reached 40 to 50 below, 80 below on 19 January. Daily maximum and minimum temperatures are presented in Fig. 3. Snow remained on the ground 64 days from 15 December to 17 February, (Fig. 4). Total snowfall during the study period was 41 cm, 18 cm (7 in) during winter and 22.9 cm (9 in) in early spring. Average annual snowfall is 91.4 cm (36 inches) and average snow on the ground during winter ranges from 13 to 18 cm (5 to 7 in) for 80 days (DTP Background Report, 1979).

The regular presence of strong winds (1 to 60 mph) caused snow to drift. Some habitat types (lowlands, brush, windrows and fencelines) accumulated snow in a snow fence effect. The uplands, ridges and parts of agricultural fields were at times blown free of snow. Cold temperatures kept the snow from melting and crusting. Only for periods of 1-2 days were all the agricultural fields covered with snow. This condition existed for only a short time after a snow fall until the winds picked up and moved the new snow. The snow melted rapidly with rising mid-February temperatures (Fig. 3) and all of the snow was gone by February 17. Wet snows of 10 and 12.7 cm occurred on 3 and 4 March respectively. This was the only wet

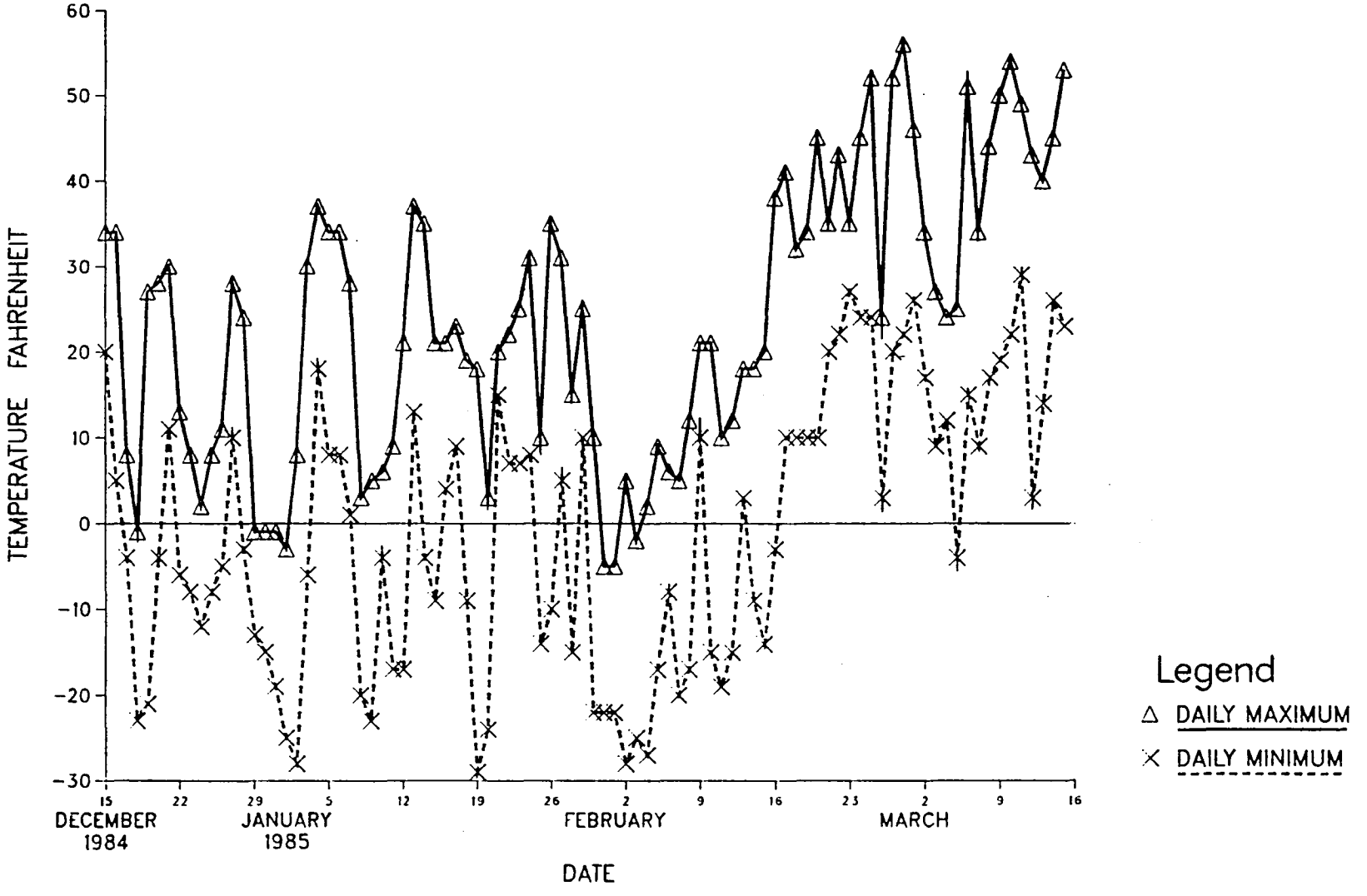

Fig. 3. Daily maximum and minimum temperatures on the Sheyenne National Grassland, 1984-85.

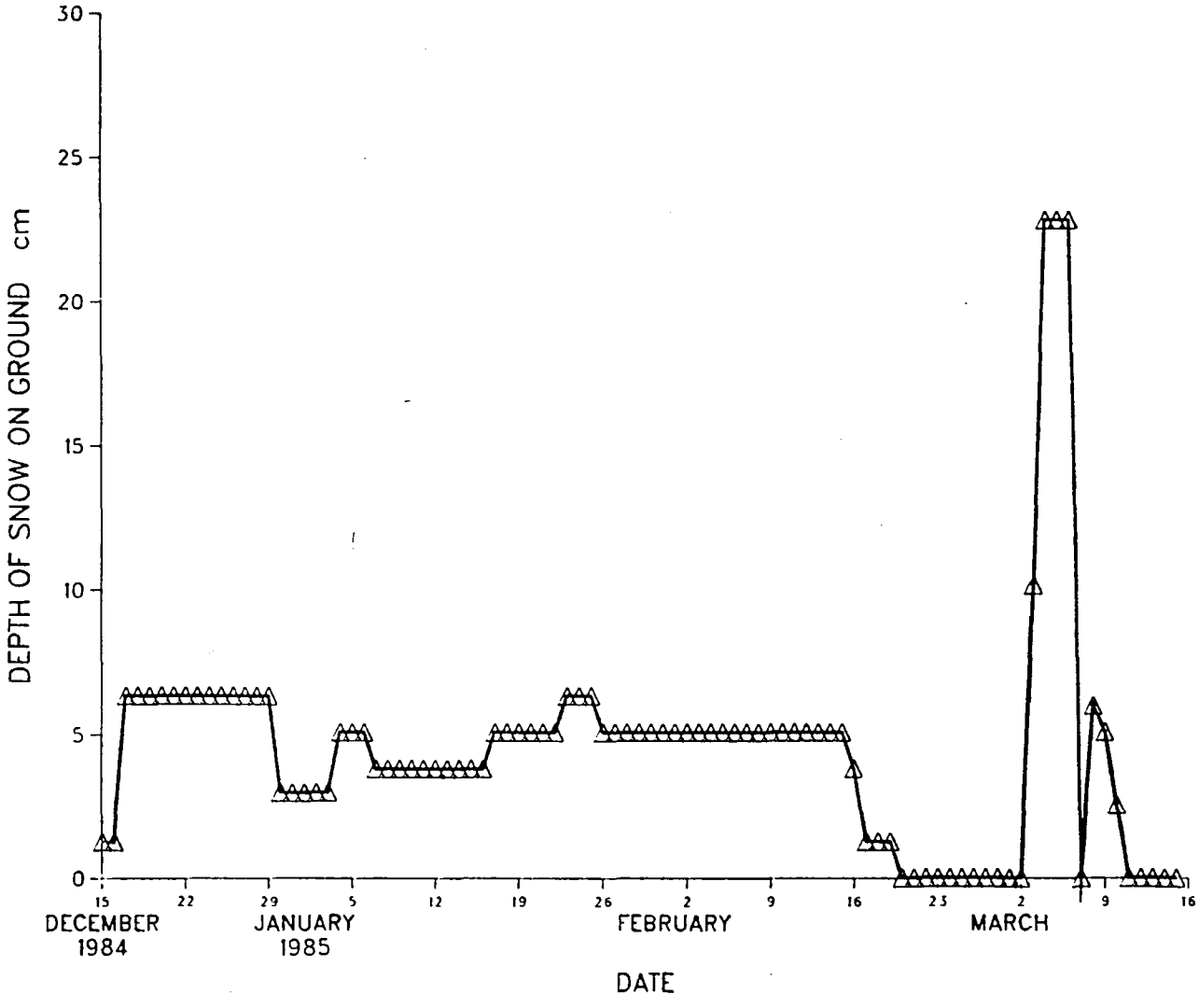

Fig. 4. Daily depth of snow (cm) on the ground on the Sheyenne National Grasslands 1984-85.

snow of the period that covered all of the agricultural fields and lasted for six days. The early spring of 1985 was unusually warm with temperatures as high as 52 F on 27 February and a mean of 28.2F(SD = 8.2).

Trapping

A total of 33 prairie chickens (18 cocks and 15 hens), 32 sharptails (22 cocks and 10 hens), and 5 prairie chicken X sharptail hybrids (3 cocks and 2 hens) were captured between 19 December, 1984 and 12 February, 1985.

Sharptails appeared to be more easily captured than prairie chickens as they were more persistent in trying to get at the bait inside a trap. In two separate instances single sharptails, moving with a flock of prairie chickens, were captured first. Visual observations indicated that once a prairie chicken became aware it was trapped, it attempted to fly and caused the remaining birds take flight. Sharptails were more tolerant of a trapped bird(s) and continued to feed enabling 2 or more to be caught at a time.

Radio-tagging

A total of 23 prairie chickens (8 cocks and 15 hens) and 11 sharptails were radio-tagged. Fourteen prairie chickens (10 hens and 4 cocks) and two sharptails (1 cock and 1 hen) received the larger more powerful SB2 transmitters. In addition to the captured birds, three radio-tagged hens from the spring of 1984 were located and followed through the winter 1984-85.

Radio Locations

A total of 5,736 radio locations (4173 day and 1563 night) were obtained during the study period 9 December, 1984 to 15 March, 1985. Twenty radioed prairie chickens (14 hens and 6 cocks) yielded 3,945 locations (2879 day and 1066 night). The 9 radioed sharptails produced 1791 locations (1294 day and 497 night). During cold weather both prairie chickens and sharptails went to roost several hours before sunset. Observations of these birds indicated they were usually night roosting, probably to conserve energy. Locations of this type were either PM or AM, but were also night locations. For movement and habitat analysis only the night location was used. There were 207 such locations. The distribution of both the prairie chickens and sharptail radio locations were evenly distributed throughout the day (AM, Midday, PM, Night) (Chi Sq. P = .47, df 3).

Flocking

Prairie chickens are flocking birds. On the SNG in winter and early spring 89 % of 335 flocks were observed in groups of 2 or more. There was no evidence that radioed birds were less social as 6% of singles observed were radioed and 17% were nonradioed. Mean flock sizes for radioed and nonradioed prairie chickens were comparable (Mean = 7.9, SD = 9.3, N = 154 vs Mean = 6.1, SD = 8.0, N = 151). Mean flock size peaked in early winter and declined through spring as the cocks spent less time in the agriculture and more time at

their booming grounds (Fig 5.) Flock sizes diminish to one for hens as they return to nesting areas and become less social. Flocks containing a radioed cock declined also, but this was thought to be due to small sample sizes in 1984-85. Data for other years shows cocks remain in flocks of 3-12 through spring and summer (Toepfer, unpubl. data). The mean number of birds in a flock varied between day and night. In the winter, mean flock size during the day was 13.8 (SD = 12.5, N = 250), while at night only 5.5 (SD = 5.5, N = 91) based on roost counts. The same pattern was observed in the spring when the mean was 5.8 (SD = 5.0, N = 60) during the day versus 3.9(SD = 2.6, N = 15) at night. This difference in flock sizes between day and night is thought to be the result of small flocks coming together in common feeding areas during the day and then separating into small groups to roost at night. The largest flock observed in the winter was 98 prairie chickens and 1 sharptail that fed regularly in a soybean field for most of the winter. A radioed hen that moved with this flock during the day usually roosted in a flock of 9, at most 15. The largest number of birds found roosting together in winter was 19. The degree of integrity of these smaller night groups is not clear. There is some shifting between groups as at times different radioed individuals roosted together for several nights, but were apart on other nights. This was true for both cocks and hens. In winter, 3 radioed birds were observed in flock of 18 to 31 during the day for most of the winter. The largest flock found

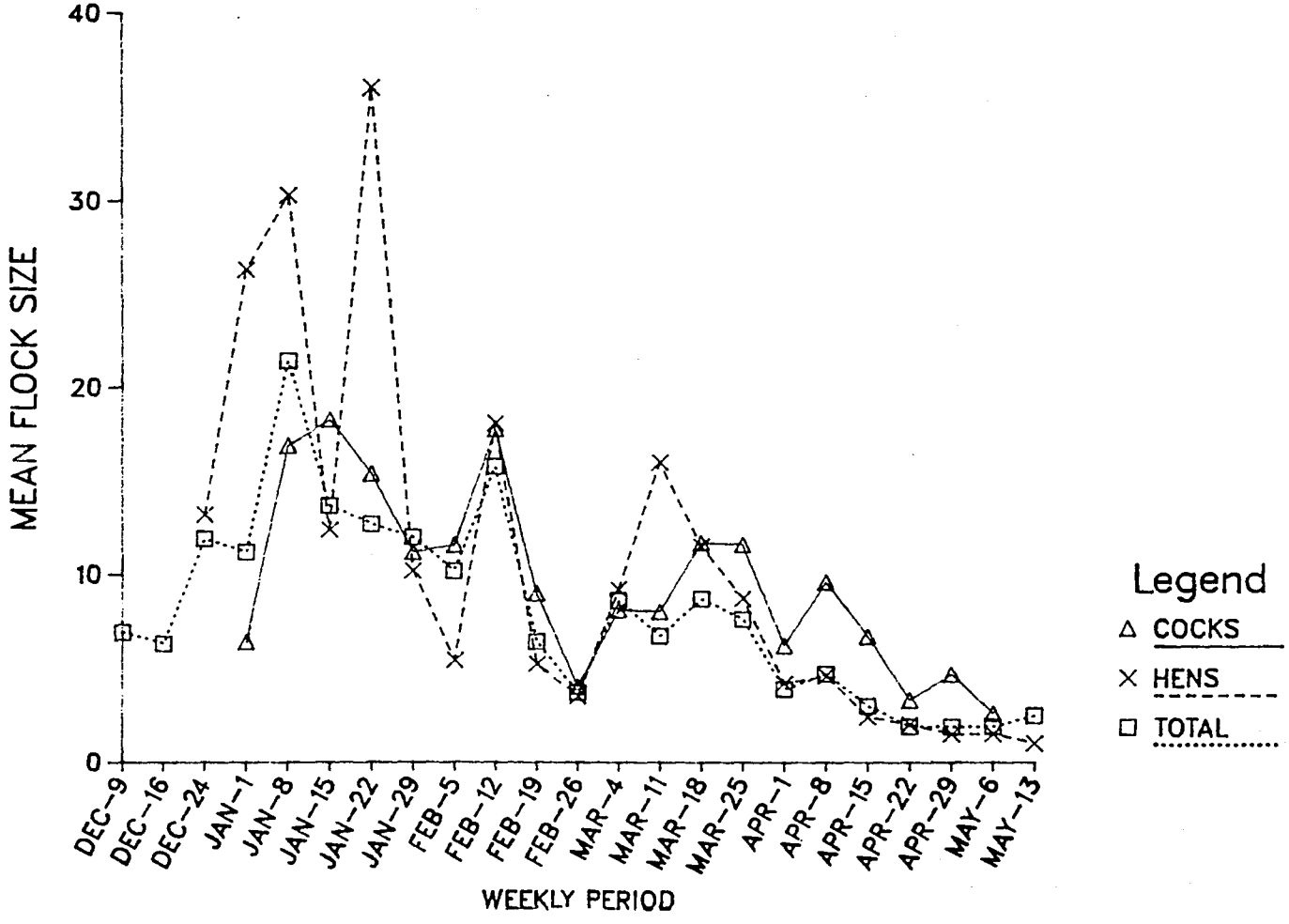

Fig. 5. Changes in weekly mean flock sizes for all prairie chickens observed and for flocks containing a radio-tagged cock or hen on the Sheyenne National Grasslands, 15 December to 15 May, 1984-1985.

together at night in this area was 11. Two other radioed hens fed together and roosted in a flock of 10-12 all winter. At times a radioed sharptail hen moved, fed and roosted with this group and at other times roosted alone. The smaller flocks found at night in spring are probably the result of social interactions between the cocks and between the hens. Three radioed hens moved and roosted together for 15 days in late March before moving to 3 separate spring areas to nest. If social grouping existed within flocks it was likely to occur in the smaller roosting flocks; however our data suggest that these winter flocks appeared to be loosely bound.

Survival

Winter survival of both radioed prairie chickens and sharptails was high at 58.8 (10 of 17) and 63.6% (7 of 11) respectively. Survival of prairie chicken cocks and hens was 66.6 (4 of 6) and 54.5% (6 of 11) respectively. Survival of radioed sharptail was 50.0% (3 of 6) for cocks and 80.0 (4 of 5) for hens. Only individuals radioed as of 7 January were used to calculate winter survival.

In addition 6 radioed prairie chickens (2 cocks and 4 hens) and 2 sharptail were killed within a week of being radioed. These birds were excluded from the survival analysis as they were in the process of adjusting to handling and placement of the radio package.

Adjustment period varies between individuals and ranged from 2.5 to 4.5 days and was characterized by the following

behavioral traits: individuals remained alone; movements were less than a 400 m (.25 miles) and were made by walking rather than flying; birds did not use usual feeding or roosting areas, and remained in thick cover, usually in the area they flew to upon being released. They often stayed in woods or windrows, areas not regularly used by prairie chickens. Tracks of indiviuals during adjustment periods indicated that they spent a great deal of time sitting in one place. Examination of droppings from night roosts showed that the birds suffered from diarreha and did not feed normally. The adjustment period ended as the bird rejoined a flock and resumed a "normal" pattern. There was no obvious evidence suggesting that the radio influenced behavior once the bird joined a flock. The effects on longterm survival however, are not known. This adjustment period is primarily due to the placement of the radio package as 2 radioed birds recaptured exhibited only a half to a 1 day adjustment period. Sharptails appeared to adjust to handling and radio-tagging faster than prairie chickens as their adjustment periods lasted only 1 or 2 days. Cold weather and status of a bird may also influence the length of the adjustment period as birds radioed in spring usually had an adjustment period of only a half to 1 day. Cocks captured on booming grounds often returned the same day and always by the following day, unless injured.

Of the seven radioed prairie chickens found dead, six were fed upon by predators (five by raptors and one by a mammal).

The seventh bird was found intact in good condition in the middle of a corn field and the cause of death was unknown. All of the birds killed in their adjustment periods were fed upon by raptors. Three birds were fed upon by both mammals and raptors and it is believed that the remains left by raptors were scavenged by foxes. Four non-radioed birds were also found dead, three were fed upon by raptors and one appeared to have hit a telephone wire while flying between feeding areas. Resident winter predators include the red fox (Vulpes vulpes), coyote (Canis latrans), badger (Taxidea taxus) and great horned owl (Bubo virginianus). Transients and temporary resident predators include red-tailed hawk (Buteo jamaicensis), northern harrier (Circus cyanesus), Cooper's hawk (Accipiter cooperii), golden eagle (Aquila chrysaetos), bald eagle (Haliaeetus leucocephalus), goshawk (Accipter gentilis), Swainson's hawk (Buteo swainsoni) and the ferruginous hawk (Buteo regalis). The high survival during the winter of 1984-85 is attributed to the moderate winter. Temperatures were cold, but total snow accumulation was 41 cm and snow cover lasted for only 64 days. In addition very few raptors were observed during the period of snow cover.

Home Range

Home ranges were calculated for all birds, but means were calculated only for those which were followed from the first week of January to 17 February. Home range sizes varied

between individuals in the same area. Appendix Table 8 shows home range sizes, period tracked, and area for each radioed prairie grouse.

Mean winter home range for all radioed prairie chickens was 8.4 km^2 (5.2 mi^2). Hens had slightly larger ranges than cocks, 8.8 km^2 (5.5 mi^2) versus 7.7 km^2 (4.8 mi^2). The ranges of immatures were larger than adults (Table 1), although sample sizes favor adult hens.

Agriculture (private) and grassland (public) were represented in all individual home ranges (Fig 6 & 7). The ratio of grassland to agriculture was variable and ranged from 20:80 to 80:20. A mean of these ratios would be meaningless since each home range was a function of the distance between night roosting in grassland and feeding in agriculture. This distance varied for many individuals during the winter as snow conditions altered the availablity of food. Thus the proximity of available food to roosting areas controls movements and sizes of winter home ranges for prairie chickens on the SNG.

Individual birds covered the largest areas of their home range in late December with the first snowfall, apparently searching for food sources. Once available food was located the bird established a regular pattern of use within the total winter home range. When new snow covered current source(s) of food, a shift in range and pattern occurred. Some birds fed in only one or two fields all winter, but roosted in many areas. In early winter cocks remained closer to a food

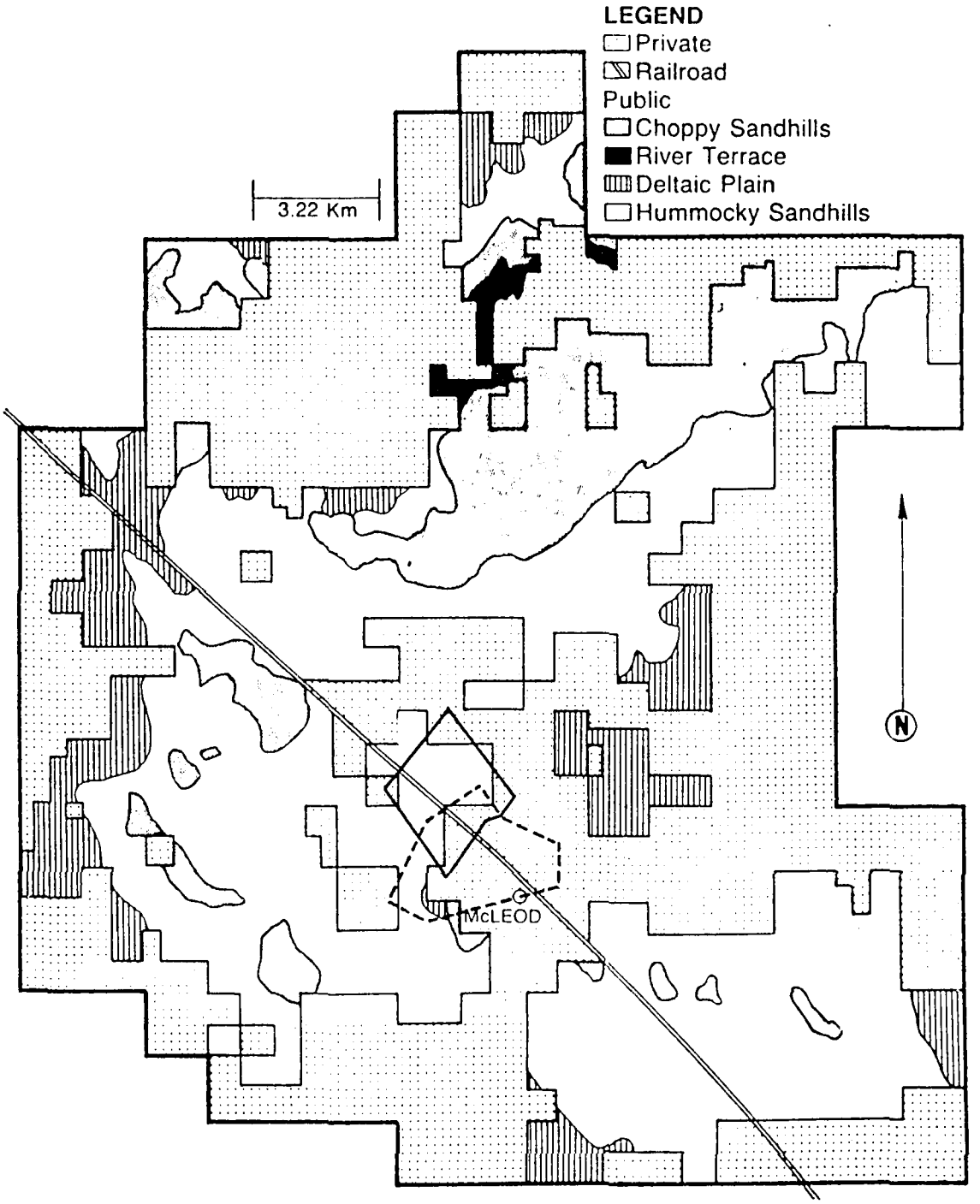

Fig. 6. Winter home ranges of two radio-tagged prairie chicken cocks, relative to private and public land, Sheyenne National Grasslands, 1984-85.

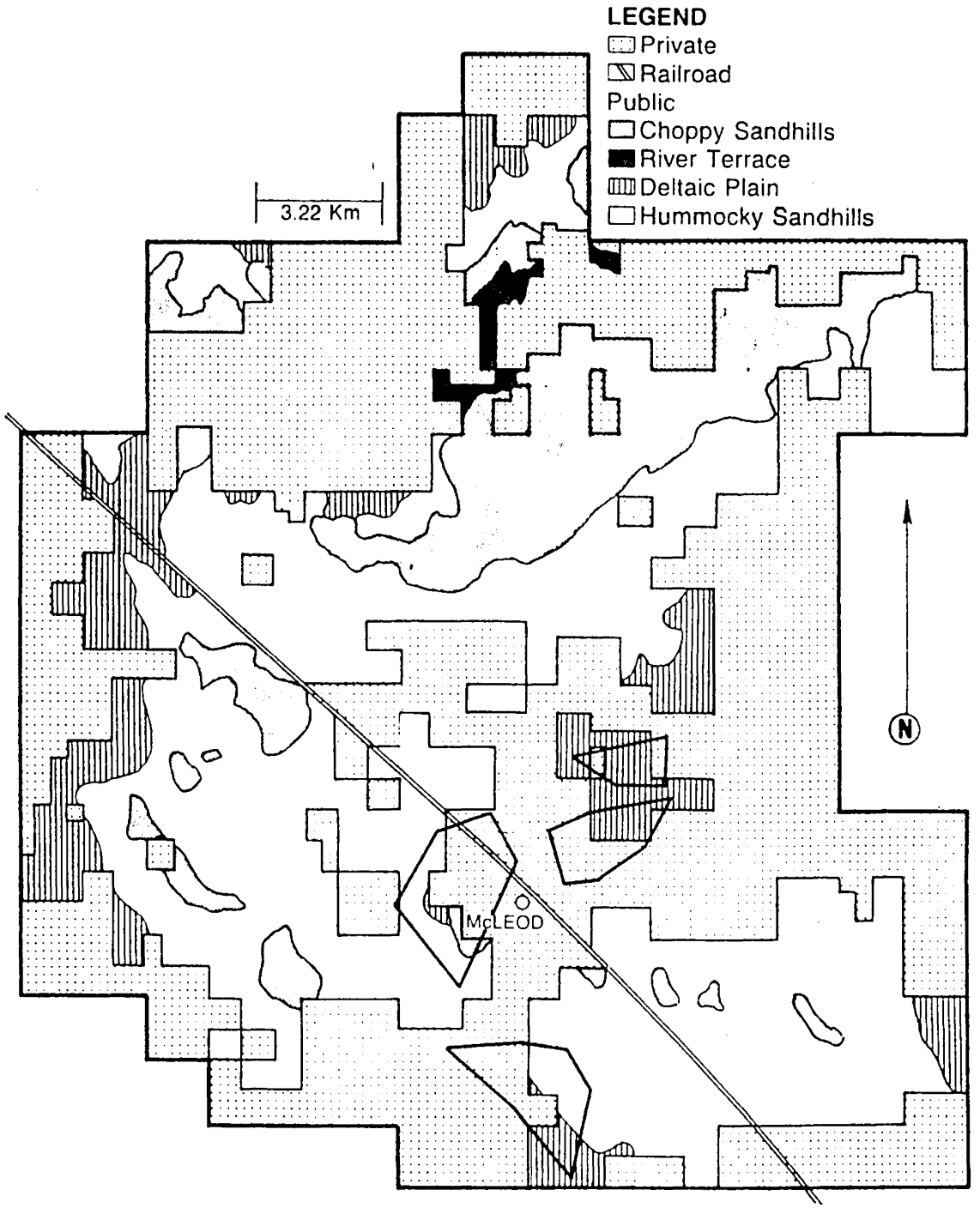

Fig. 7. Winter home ranges of four radio-tagged prairie chicken hens, relative to private and public land, Sheyenne National Grasslands, 1984-85.

Table 1. Mean home range sizes (sq km) for radio-tagged prairie chickens during winter, (15 December - 17 February), Sheyenne National Grasslands, North Dakota, 1984-1985. Area in square miles in parentheses.

	Area	Standard Deviation
Adult hens		
Mean	8.7(5.4) N=7	4.6(1.8)
Immature hens*		
Mean	9.3(2.76) N=2	3.2(0.1)
Total Hens		
Mean	8.8(5.5) N=9	4.0(1.8)
Adult cocks		
Mean	7.2(2.8) N=4	3.2(1.3)
Immature cocks		
Mean	9.8(3.8) N=1	
Total cocks		
Mean	7.7(4.8) N=5	
Total		
Mean	8.4(5.2) N=14	3.6(2.2)

source than booming ground, but in early February they expanded their ranges to include their home booming ground. The largest home range was that of an immature cock that used the areas covered by 3 other radioed birds in 3 separate flocks. Early spring home ranges were not calculated as they represent only part of a season.

Movements

Winter to Spring

The mean maximum distance that radioed prairie chickens moved from winter to spring ranges (cocks to home booming ground hens to nest) was 4.4 km for cocks and 6.4 km for hens. That cocks remained closer than hens to their home ground was also shown by the mean minimum distances moved (0.2 km for cocks and 3.2 for hens). Cocks, unlike some hens made no long movements back to home booming grounds as all remained within 5.0 km. Table 2 shows mean distances moved by radio-tagged prairie chickens from winter to spring areas. Distances moved by individual radioed prairie chickens are presented in Appendix Table 9.

Of the cocks, one immature moved 6.9 km (4.3 mi) the farthest from his eventual home booming ground, while covering a large area between three booming grounds in early March. He was known to have visited all three grounds, apparently in an effort to establish a territory.

Hens exhibited two general movement patterns in shifting from winter to spring range. Several hens wintered within .8 to

Table 2. Mean distance radio-tagged prairie chickens and sharptails moved from winter range to spring areas (hens to nest and cocks to home booming ground) 1984-1985, Sheyenne Grasslands, North Dakota. Distance in miles in parentheses.

	Prairie Chicken			Sharptail		
	Distance			Distance		
	Maximum	Minimum		Maximum	Minimum	
Adult hens						
Mean	6.4(4.0)	3.2(2.0)	N=12	3.5(2.2)	0.2(0.1)	N=1
SD	2.4(1.5)	2.5(1.6)				
Immature hens						
Mean	6.1(3.8)	3.2(1.9)	N=3	6.6(4.1)	3.2(2.0)	N=3
SD	2.3(1.4)	2.3(1.3)		1.9(1.2)	1.6(2.2)	
Total hens						
Mean	6.4(4.0)	3.2(2.0)	N=15	5.8(3.6)	2.4(1.5)	N=4
SD	2.4(1.5)	2.3(1.4)		2.1(1.3)	2.6(1.6)	
Adult cocks						
Mean	4.0(2.5)	0.2(0.1)	N=4	2.7(1.7)	0.2(0.1)	N=1
SD	0.3(0.2)	0.1(.05)				
Immature cocks						
Mean	0.6(4.0)	0.3(.01)	N=1	2.4(1.5)	0.5(0.3)	N=3
SD				0.2(0.1)		
Total cocks						
Mean	4.4(2.7)	0.2(0.3)	N=5	2.5(1.5)	0.5(0.3)	N=4
SD	1.5(0.9)	0.2(0.1)		0.3(0.2)	0.2(0.1)	
Total						
Mean	5.8(3.6)	5.0(3.1)	N=20	4.2(2.6)	1.4(0.9)	N=10
SD	3.1(1.9)	2.4(1.5)		2.3(1.4)	2.1(1.3)	

1.6 km of their spring areas, while other hens moved considerable distances to eventual nest sites (Appendix Table 9). Those which wintered close to spring ranges were in winter areas with more agriculture than grassland. Those which moved greater distances had spring areas which were characterized by large amounts of grass with little agriculture. It is felt that these more extensive movements were related to winter food, with birds either returning to traditional food sources or birds moving until they found an adequate source. More extensive moves made by adult hens to nesting areas suggested homing to the previous years nesting area. Two hens that were followed during two springs nested in 1985 within 100 m of their 1984 nests. Four other hens had nests which were found two years in a row (1 three) and all but one nested near the same booming ground.

Movements made from winter to spring areas by adult hens were made quickly (1 to 2 days), were directional with no wandering, and each hen localized very soon near their eventual nest site. Only three immature hens were followed to nests and they showed no rapid movements that might suggest homing. They also localized later and more slowly than adult hens.

Relationship to Booming Grounds

The winter distribution of prairie chickens on the SNG coincided closely with that of the booming grounds; for the most part, all birds remained within 3 km of a display ground. None of the radio-tagged prairie chickens were known to have left the SNG during the winter of 1984-85. All non-booming ground radio

locations (N = 2444) and observations (N = 1985) of prairie chickens were within 6500 m (4 miles) of a known booming ground. The mean distance from radioed bird locations to nearest booming ground was 2007 m (SD = 980) in winter with 64.8 % within 2400 m (1.5 mi). The mean for nonradioed birds was 1921 m (SD = 1001), with 68.1% within 2400 m. The locations of radio cocks in the winter were closer to the booming grounds than hens (Table 3). The close proximity of cocks to booming grounds reflects the strong association to their home ground. Evidence indicated that the cocks attempted to stay as close to home ground as winter conditions and surrounding habitat permits. Hamerstrom et al. (1957) and Hamerstrom and Hamerstrom (1973) reported similar findings. Schwartz (1945) felt that there was a "sphere of influence around each booming ground". Hens showed much less association to a particular booming ground in winter than cocks, as only 49.5% of their locations were within 4000 m (2.5 miles) of their home booming ground (Mean = 4072 m, Table 3). Hens as a group showed little association to their nest sites during the winter. The mean was 4299 m with only 54.9% within 4000 m (2.5 mi) during the winter. During winter hens were nearer a booming ground than their nests (2327 m versus 4299 m). As winter progressed prairie chickens, particularly adult cocks shifted closer to booming grounds. The mean distance decreased in early spring with cocks being closer than hens (1302 m versus 2004 m, Table 3 and Fig. 8). The distribution also changed as the

Table 3. Mean distances to nearest and home booming ground and nest for radio-tagged prairie chickens, Sheyenne National Grasslands, North Dakota, 1984-1985. Number of locations in parentheses.

	Cocks			Hens		
	Adult N=4	Immature N=2	Total	Total	Adult N=12	Immature N=3
Distance Nearest Booming Ground						
Winter	1845± 713(582)	1661± 679(203)	1797± 709(785)	2327±1178(1659)	2140±1150(1251)	2900± 586(408)
Early Spring	1102± 689(185)	1631± 579(112)	1302± 697(297)	2004± 898(1116)	1886± 930(789)	2287± 745(327)
Distance Home Booming Ground						
Winter	2755±1127(582)	2030±1322(203)	2568±1222(785)	4072±1975(1373)	4282±2125(965)	3575± 967(408)
Early Spring	1424±1124(185)	1941±1078(112)	1619±1133(297)	3662±1974(1104)	3889±2140(777)	3122±1373(327)
Distance Nest						
Winter				4299±2144(1283)	4426±2383(875)	4026±2001(408)
Spring				3932±1960 (986)	4075±2374(659)	3643±1546(327)

population moved towards booming grounds. Cocks were the closest with 94.3 % within 2400 meters (1.5 mi). Hens also moved towards booming grounds, but less so than cocks as only 79.5 % were within 2400 meters. Both adult cocks and hens were closer than their immature counterparts (Table 3).

The cocks returned to booming grounds in February, one radioed cock was observed on 5 February and two others on 10 February. Hens returned to home booming ground and nest areas in late March, and early April. Adult hens moved towards nests earlier and remained closer than immatures. Figures 8, 9, and 10 show mean changes in distance to nearest booming ground, home booming ground and nest on a weekly basis.

A measureable relationship is present between prairie chickens and booming grounds. No relationship was demonstrated between prairie chickens and the nearest sharptail dancing ground (Fig. 11). Measurements of radioed sharptails showed that they like prairie chickens, moved and shifted activities towards the dancing grounds from winter to spring (Fig. 12). Likewise, sharptails showed little tendency to move towards prairie chicken booming grounds. The two species tended to segregate in the spring, but not completely as some sharptail cocks displayed on booming grounds and some prairie chickens displayed with sharptails. Sharptail hens have been observed and captured on booming grounds and nested nearer booming grounds than sharptail dancing grounds. Although the sample size was not large,

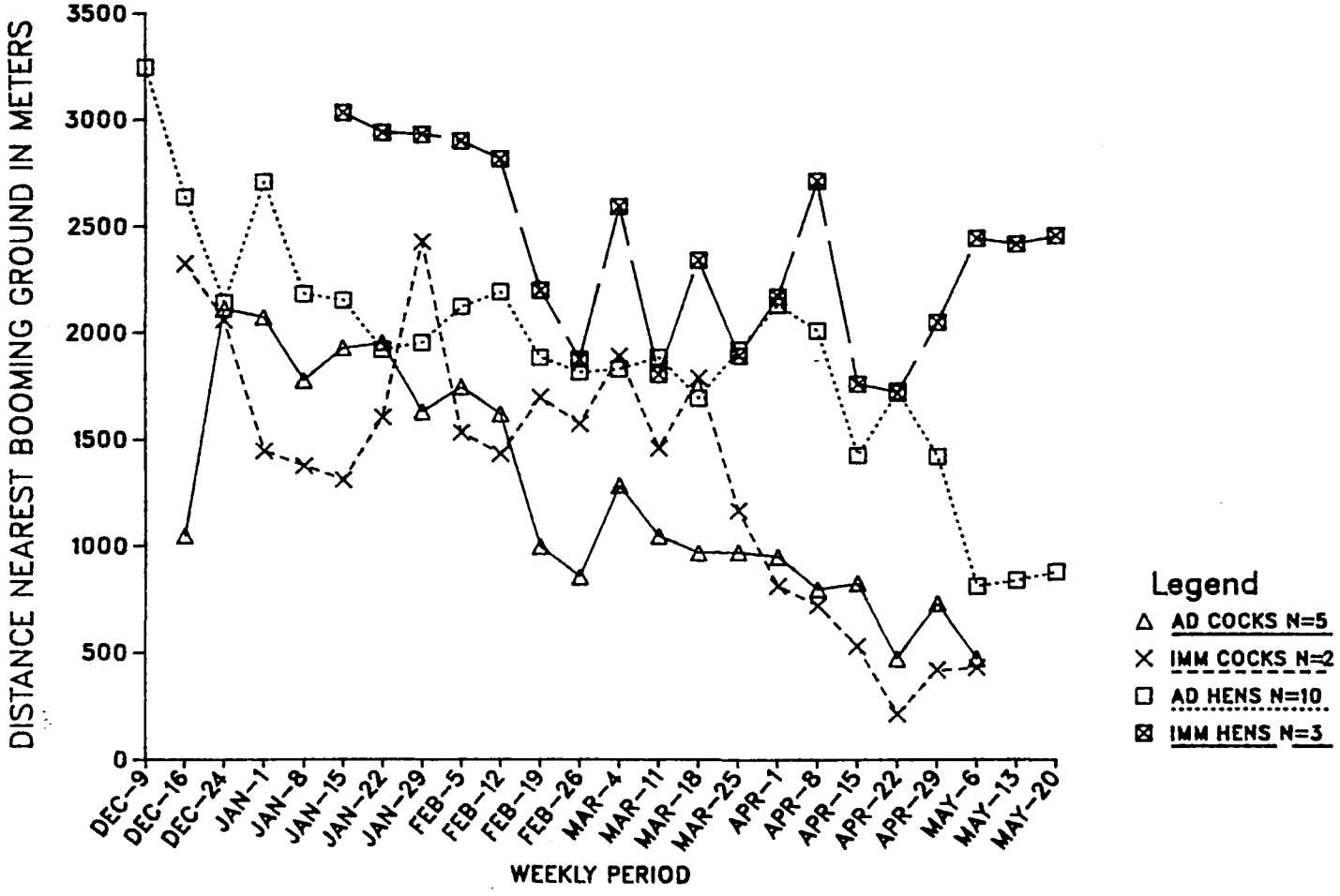

Fig. 8. Weekly mean distances to the nearest booming ground for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 20 May, 1984-85.

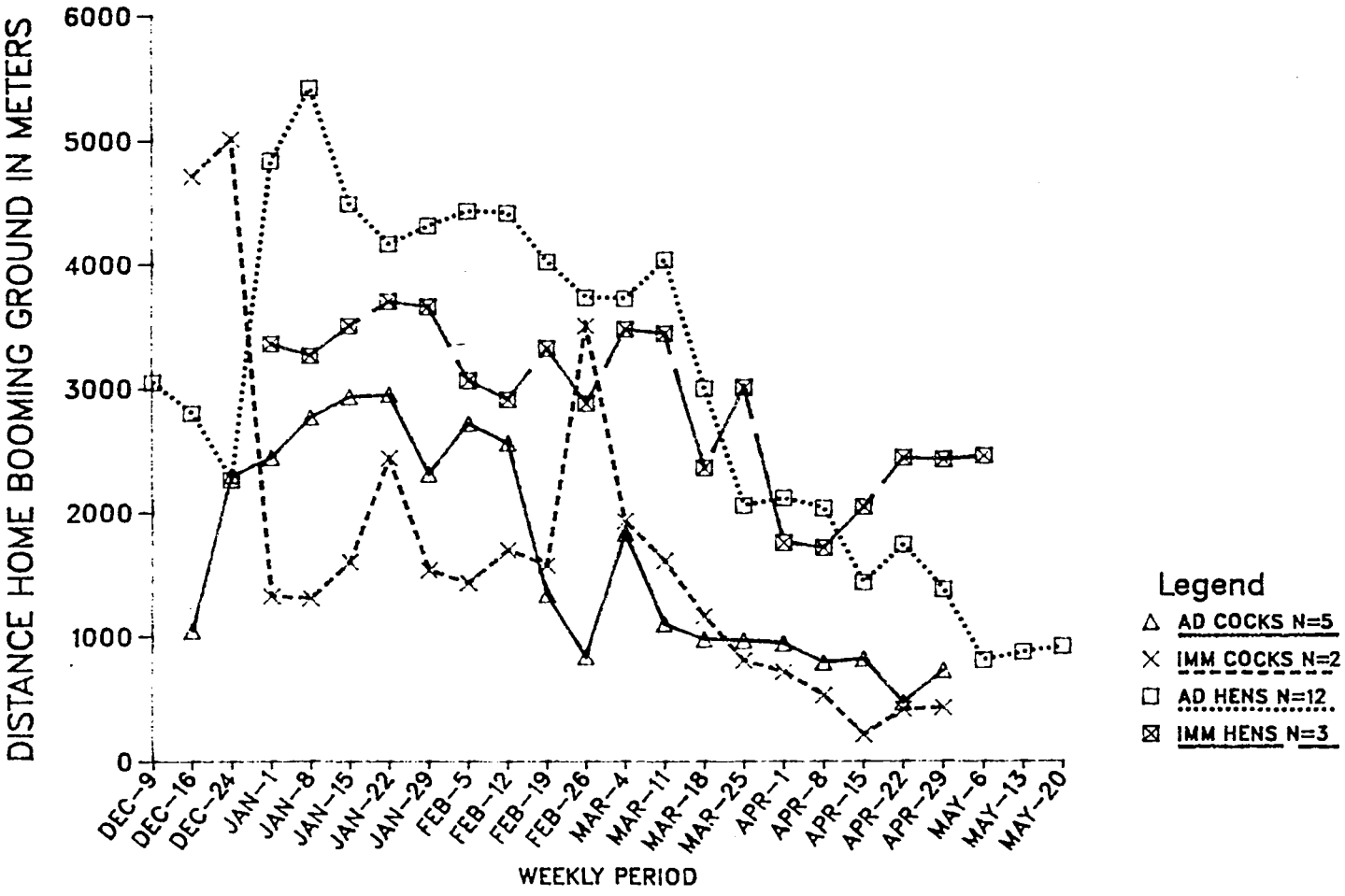

Fig. 9. Weekly mean distances to home booming ground for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 20 May, 1984-85.

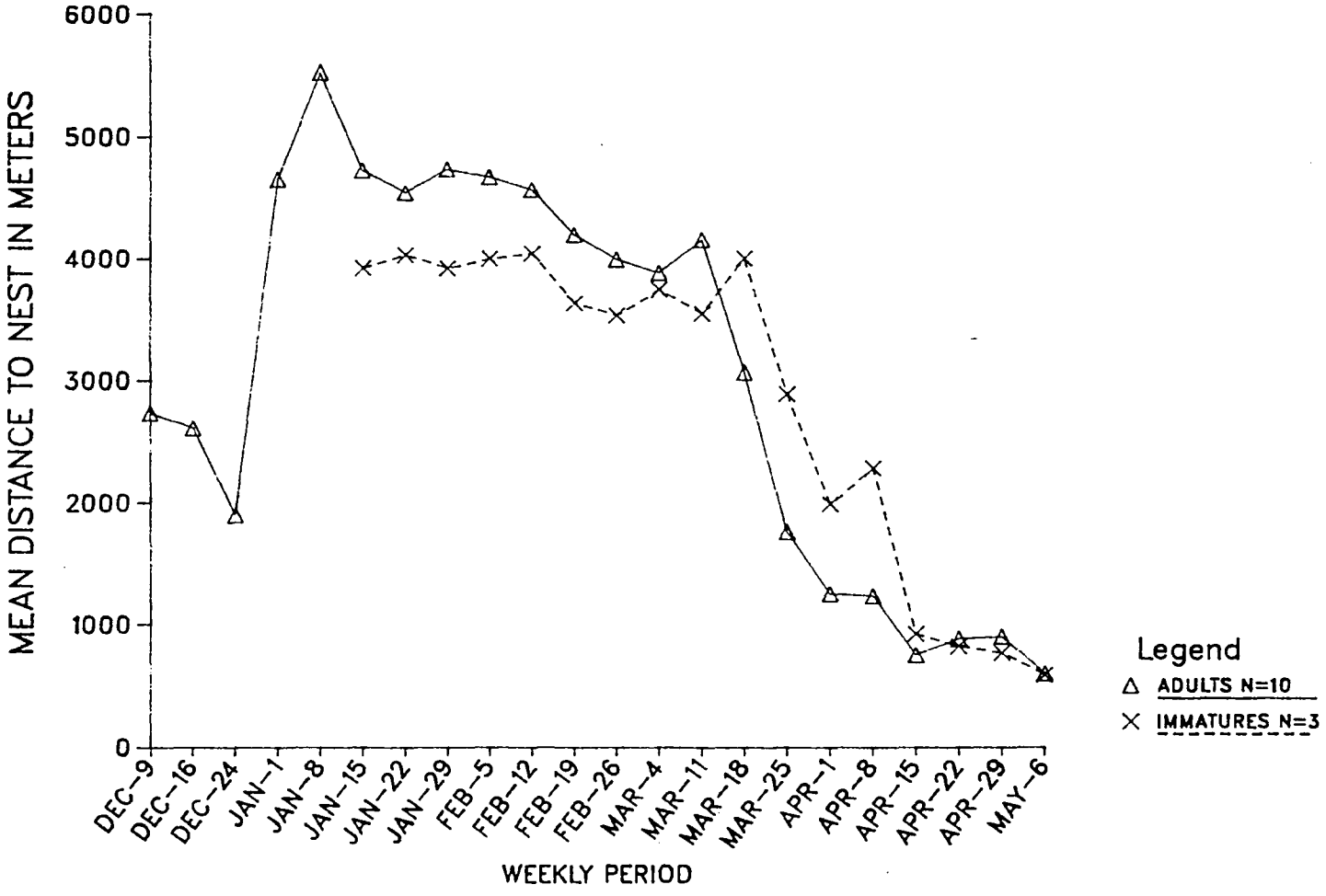

Fig. 10. Weekly mean distances to nest for radio-tagged prairie chicken hens, Sheyenne National Grasslands, 9 December to 20 May, 1984-85.

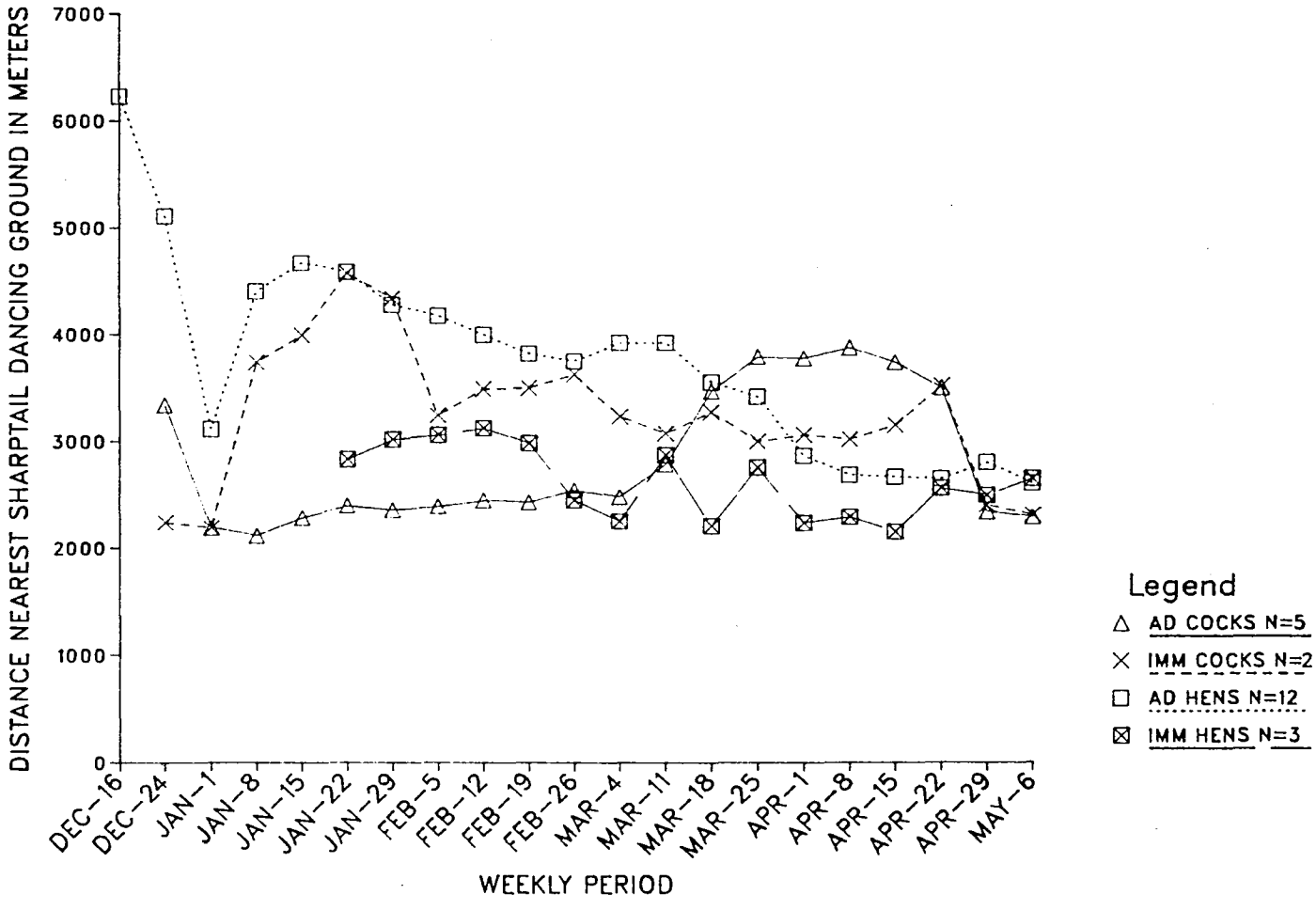

Fig. 11. Weekly mean distances to the nearest sharptail dancing ground for radio-tagged prairie chickens, Sheyenne National Grasslands, 16 December to 20 May, 1984-85.

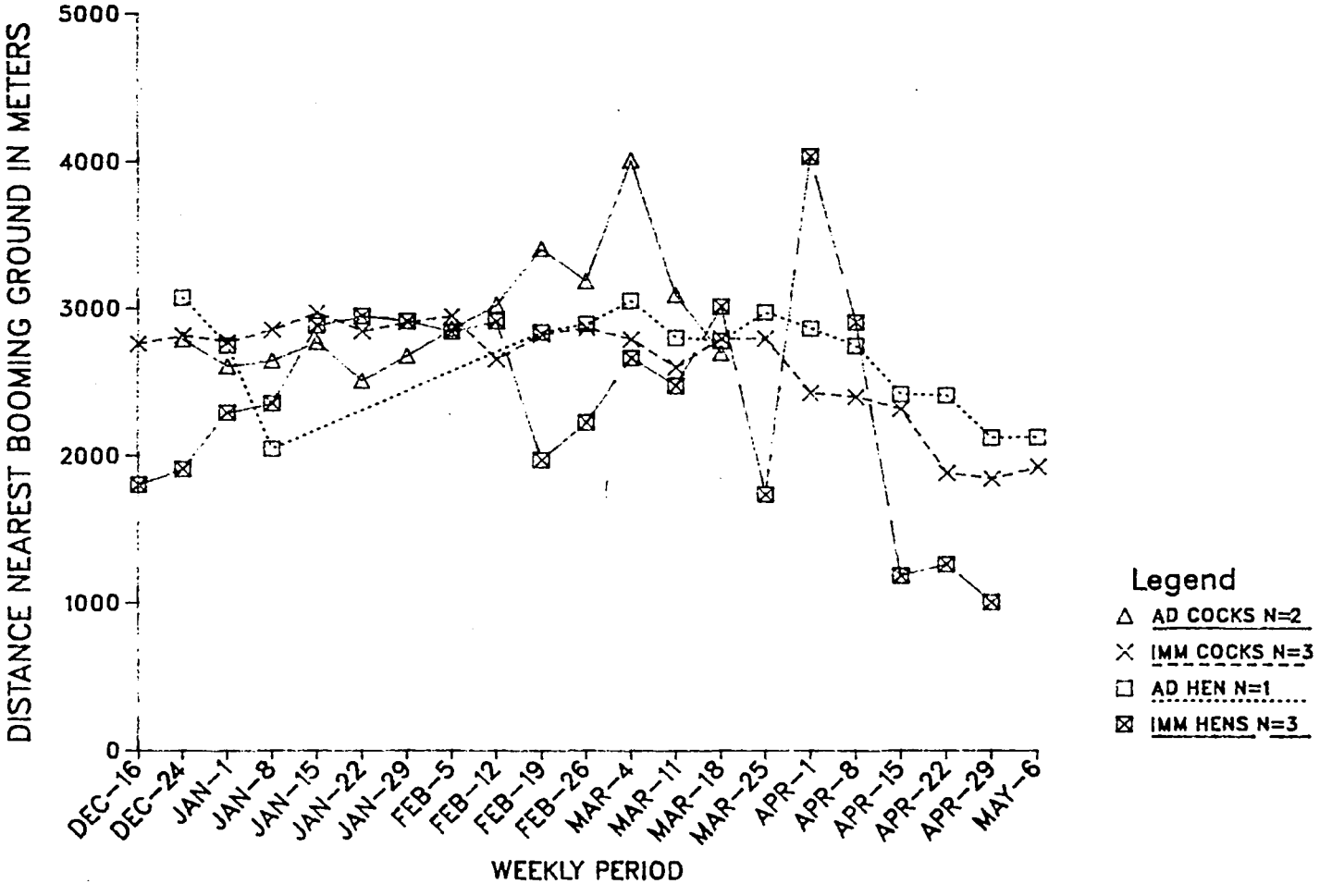

Fig. 12. Weekly mean distances to the nearest booming ground for radio-tagged sharptails, Sheyenne National Grasslands, 16 December to 20 May, 1984-85.

invasion of prairie chicken booming grounds by sharptails was primairly by immatures (Cocks 7 of 7, Hens 2 of 3).

A strong tendency existed for prairie chickens to remain in areas near a booming ground. Even in the winter, birds that moved 10,000 m (6.2 mi) from their nest or home booming ground still remained in the vicinity of a booming ground. This suggests that the area within 3.2 km (2 mi) of any given booming ground is the key to prairie chicken habitat management. This area could serve as an effective management unit or a group of grounds as a complex in which management could focus its activities.

Daily Movements

An index to daily movements was calculated by measuring the distance between day to night locations (DN), distance between consecutive daily locations (DD) and the distance between consecutive night locations (NN). The latter two measurements should not be considered movements since they often represent a bird carrying out a daily activity on successive days, a pattern which is often repetitious. Distances (DD) are presented briefly so comparisions may be made with Robel et al. (1970). The distances (NN) were used to show relative fidelity to the previous night's location. The distances (DN), are close approximations of the distances moved between feeding and roosting areas. Movements were broken down by sex only as immatures and adults appeared to move together on a daily basis.

Distance (DN) in winter were 1085 m (S = 778, N = 852) and were greater for cocks than hens (Mean = 1358 m, SD = 909, N = 132 versus 1035 m, SD = 855, N = 720). The greater day to night movements for cocks is a result of their initiating morning visits to their booming grounds in the late winter. Hens centered their movements near feeding areas and showed no interest in the booming grounds or nest sites during winter and early spring. The maximum distance moved from day to night in winter was 4 km (2.5 mi) for a cock and 4.1 km (2.7 mi) for a hen.

Distances (DD) were much less than those of DN and also greater for cocks than hens (Mean = 992 m, SD = 711, N = 167 versus Mean = 899 m, SD = 788, N = 700). Distances between locations on successive days approached zero if individuals used the same area daily, which happened often. Although movements recorded from day to night were basically a measure of distances between feeding and roosting areas, not all birds used either the nearest available feeding area or the nearest roost. The movements made to and from roosts were often made in one long flight, but at times were broken into two. Prairie chickens in winter are cautious in approaching feeding and roosting areas and usually land nearby and walk or make a low final flight.

After the snow melted in early spring the distance (DN) for both cocks and hens declined as food and cover became more available. The mean was 1074 m (SD = 938, N = 74) for cocks and

709 m (SD = 584, N = 121) for hens. These mean distances are 21 percent less for cocks and 32 % less for hens than their respective winter means. Hamerstrom and Hamerstrom (1949) and Ammann (1957) also indicated that prairie chickens are most mobile in the winter. Figure 13 shows the changes in distances (DN) for weekly periods on the SNG in 1984-85.

The greater movements of cocks in early spring was due to their twice daily visits to booming grounds, plus flights to the agricultural areas to feed. One group of displaying cocks with two radioed birds fed on waste grain along the nearby (.5 km) railroad tracks. The above is the only instance during 1984-85 where radioed birds were known to feed along the tracks even though all but 3 radioed birds were at sometime during the winter within 400 m of the railroad. The railroad maintenance crews regularly reported birds on the tracks and Manske and Barker (1981) reported repeated winter feeding along the railroad tracks by prairie chickens.

One adult cock fed in the same corn field in the early spring, that it used all winter, the only agricultural field within 1.6 km (1 mile) of its booming ground.

In early spring hens were not yet associated with a particular booming ground or their eventual nest areas and their movements were localized closer to their feeding areas. All of the radioed hens spent the first four weeks after the snow melted moving only as far as necessary from roosting areas to feeding areas (less than 600 meters) (Fig. 13). This

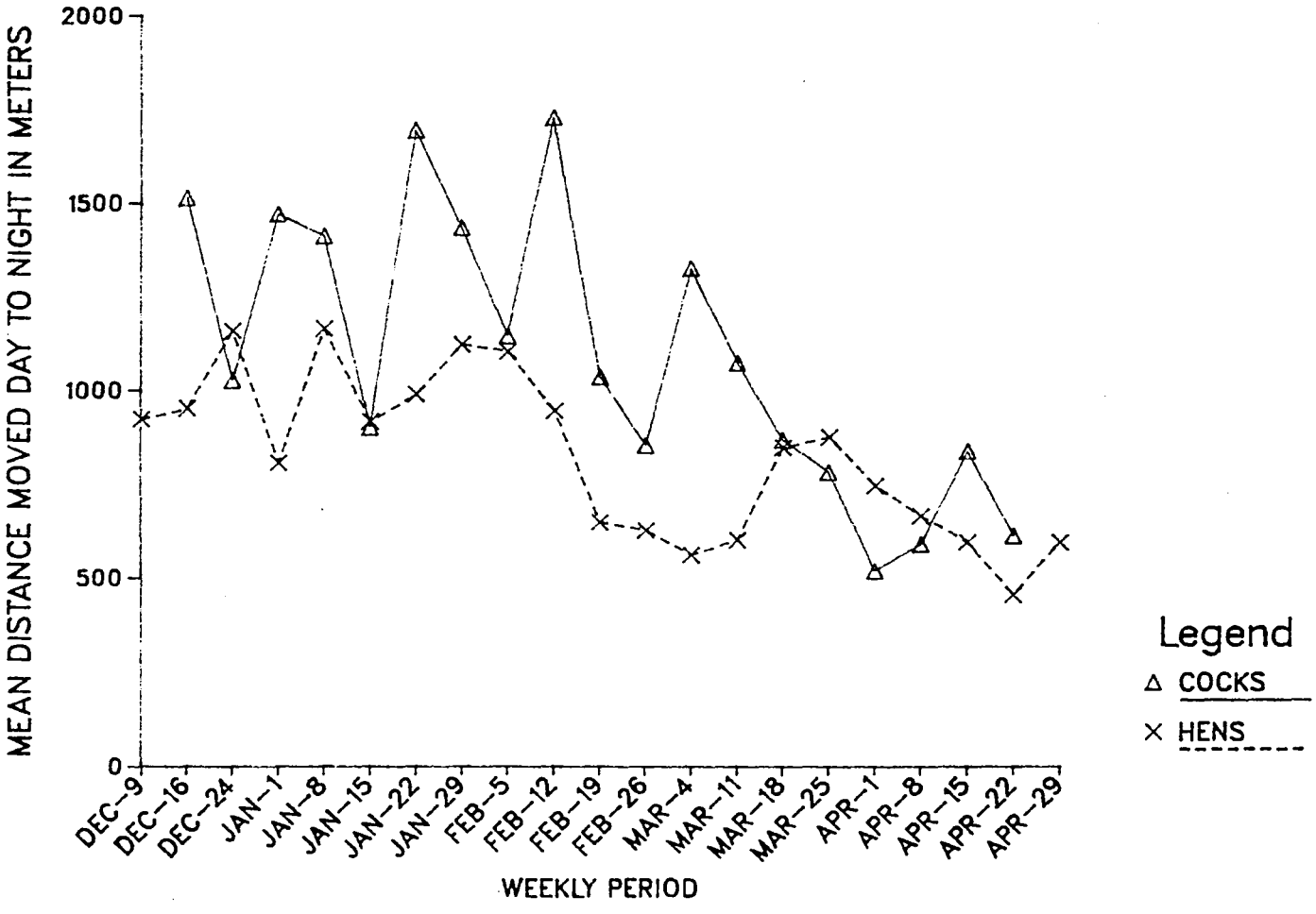

Fig. 13. Weekly mean distances moved from day to night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 20 May, 1984-85.

reduction in movements may have allowed hens to recover lost weight.

Mean distances (NN) locations were 922 m (SD = 770, N = 445) in winter for cocks and 949 m (SD = 816, N = 174) for hens. With one exception, prairie chickens did not use the same roosting area on successive nights in the winter, the closest recorded being 60 m. The exception involved two radioed birds which used the same roost area 3-4 nights in a row before changing. These two birds spent most of the winter on private land and had only three undisturbed roost sites near their feeding areas. Their pattern was irregular, but they too shifted between the three available roosting areas. The two areas closest to food also doubled as a day roosting area. This tendency to use several roost areas in the winter points out the need for a good distribution of roosting cover.

Once snow melted and individuals began to use the same areas on successive nights the mean weekly distance NN declined (Fig. 14). Use of the same roost area on successive nights in spring and not winter is believed to be due to an increase in security due to more available cover. Some of the same roosting areas used only once in the winter were used regularly on successive nights in the early spring.

Distances (NN) became less for cocks as their activities become concentrated near the booming ground. Once hens moved to their nesting areas they remained within 1.6 km of their nests. The greatest distance (NN) for hens occurred during the last

week in March when they moved from winter to spring areas (Fig. 14).

Cold temperatures and snow have the greatest influence on the daily movement patterns of prairie chickens. Fresh snow caused individuals to increase their within day movements when normal food sources were covered. Snow also caused abandonment of roost areas as new snow altered cover.

Inclement weather decreases movements and can prevent birds from following their normal daily activities. On 19 January, with high winds (60 mph) snow and cold temperatures (wind chill 60 below), at least three radioed birds altered their usual daily patterns. These birds visited their normal feeding area in the AM, but left early at 1030 hours and moved only 400 meters to roost where they remained until the following day. The blowing snow covered the birds at night as they had to break out from the drifted snow the following day. Dropping counts indicated the birds fed little the previous day as a maximum of eight droppings instead of the normal 15-30 were found in each roost. At least three other radioed birds appeared to have remained within 100 meters of the previous nights roost.

The influence of snow on movements was also observed on 3 and 4 March when 22 cm fell covering most of the normal food sources for three days. Cocks and some hens increased their ranges and moved back to areas used only in midwinter. Some cocks made long flights of up to 3.2 km (2 mi) from their booming

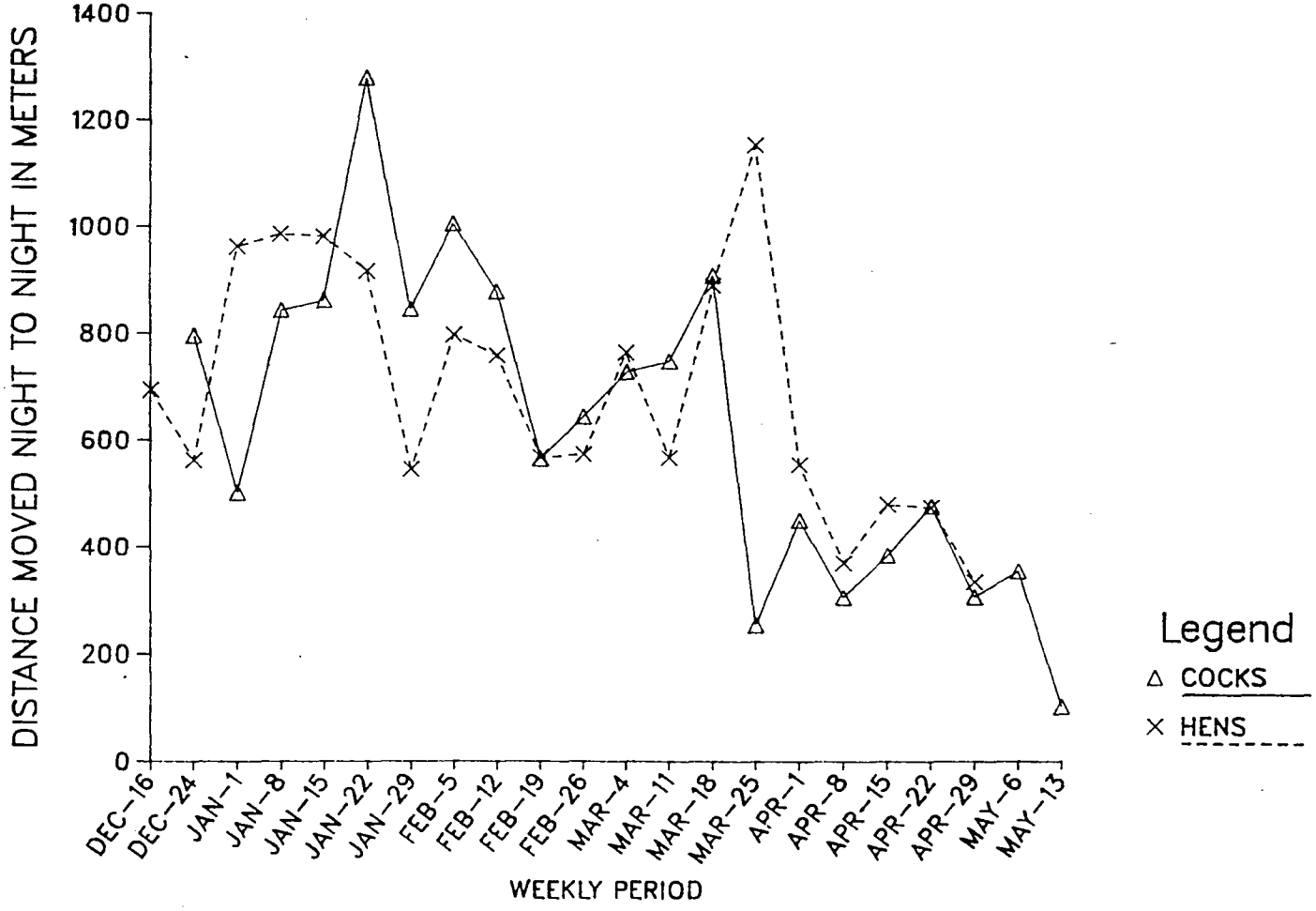

Fig. 14. Weekly mean distances between successive night locations for radio-tagged prairie chickens, Sheyenne National Grasslands, 16 December to 20 May, 1984-85.

grounds to agricultural areas with available food. The mean distances (DN) for cocks during this period was 1522 m (SD = 1035, N = 20). This was 11 % greater than in the winter. Hens, reduced their mean daily movements (DN) to 534 m (SD = 394, N = 15). Most hens expanded their ranges by moving back to winter areas, but this is not shown in day to night movements (DN) as hens roosted closer to food sources and unlike cocks did not return to the booming grounds.

Prairie chickens responded to long periods of sub-zero temperatures by reducing activity. They remained in their roosts longer in the AM, fed in the agriculture later or during midday, flew to their roosts earlier than normal, (as early as 1400 hours) and remained in roost areas until the following day (15 to 17 hrs). Visual documentation was obtained of individuals in snow burrows several hours before they would have gone to roost in milder weather or at other times of the year (Toepfer unpubl. data). Reduced activity during cold temperatures is thought to be an energy conservation mechanism. It appears that several days of very cold weather are necessary for prairie chickens to initiate this type of behavior. Hamerstrom and Hamerstrom (1949) observed similar behavior in prairie chickens during very cold or stormy weather in Wisconsin.

Habitat Use

Four major habitat components appear to determine the quality of prairie chicken habitat: type, height (form), disturbance and space (open treeless areas). All four are closely related to one another and most are more closely associated with cover structure than species composition. Height or form appears to be the critical component as it creates the structure of the available cover that prairie chickens actually use. This is not new, but is based on the life form concept as applied by Hamerstrom et al. (1957) and Jones (1963). From a management perspective disturbance is a key factor as it determines height, and influences the amount and distribution of cover. Disturbances relative to landownership and land use practices in an area determine the available habitat types and open space.

A total of 3674 radio locations of prairie chickens from 15 December to 15 March were used in habitat analyses. Booming ground observations and unknown habitat types were excluded. Tree(s) were not included in the analysis of height and disturbances. No effort was made to analyze habitat use relative to the amount available in the study area. Observations in the field showed that the total amount of a habitat type available did not determine use and was not a valid index to what prairie chickens preferred. These indicies or importance values relate only to conditions under which they were collected and do not take into account the habitat needs of animals during other

critical times (nesting, brood rearing). To be effective management must relate winter use to the habitat used at other times of the year.

Winter

Overall, the agriculture and grass habitat types totaled 71.3% of the habitat used by radio-tagged prairie chickens in the winter of 1984-85, on the SNG. Other studies indicated similar habitat use patterns (Schwartz 1945, Grange 1948, Hamerstrom and Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al 1957, Mohler 1963, Robel et al. 1970a, and Horak, 1985). A breakdown by habitat type showed that agriculture made up 41 % of the total use, grass 29.6 %, followed by trees and shrubs at 9.0 and 7.6 %. Edges between types, primarily agriculture and grass, made up 6.8 %. The remaining use was split between forbs, and wetlands (Table 4).

Corn (picked and silage) made up 70.8 % of the agricultural types followed by oats and sunflowers at 8.6 and 8.0 %. These difference are misleading as not all birds had all of the agricultural types available within or near their ranges. Some individuals used corn all winter, while others used corn and/or sunflowers. One radioed hen in association with 50-98 other birds fed throughout the winter in a 10-acre soybean field which was blown free of snow and located between two corn fields. These birds fed in the soybeans and, loafed and day roosted in the picked corn or nearby ditches. This hen and others fed in a field of sunflowers 0.5 km north of the soybeans before shifting

Table 4. Habitat type use by time of day (%) for radio-tagged prairie chickens, winter (12 December - 17 February) and early spring (18 February - 15 March), Sheyenne Grasslands, North Dakota, 1984-1985. Number of locations in parentheses.

	Winter					Early Spring				
	Time of Day					Time of day				
Habitat Type	AM	Midday	PM	Night	Total	Total	AM	Midday	PM	Night
Agriculture	78.9(491)	31.0(215)	50.8(229)	3.8 (20)	41.7 (955)	43.6 (603)	78.1(250)	23.8 (88)	70.4(236)	8.1 (29)
Picked corn	47.4(234)	67.9(146)	57.2(131)	60.0 (12)	54.8 (523)	47.9 (289)	48.0(120)	37.5 (33)	55.1(130)	20.7 (6)
Silage corn	16.7 (82)	13.5 (29)	18.3 (42)	0	16.0 (153)	11.8 (71)	15.2 (38)	6.8 (6)	11.4 (27)	0
Oats	10.2 (50)	4.7 (10)	7.9 (18)	20.0 (4)	8.6 (82)	1.7 (10)	2.0 (5)	1.1 (1)	1.7 (4)	0
Sunflowers	10.0 (49)	3.3 (7)	8.7 (20)	0	8.0 (76)	18.2 (110)	24.4 (61)	17.0 (15)	14.4 (34)	0
Soybeans	9.0 (44)	0.9 (2)	5.7 (13)	0	6.2 (59)	0.3 (2)	0.4 (1)	0	0.4 (1)	0
Alfalfa	3.5 (18)	5.1 (11)	1.3 (3)	20.0 (4)	3.6 (36)	20.1 (121)	10.0 (25)	37.5 (33)	16.9 (40)	79.3 (23)
Haystack	2.9 (14)	4.7 (10)	0.9 (2)	0	2.7 (26)	0	0	0	0	0
Grass	9.3 (58)	25.5(177)	21.1 (95)	66.7(350)	29.6 (680)	37.6 (520)	12.2 (39)	37.8(140)	18.2 (61)	78.4 (280)
Lowland	39.7 (23)	35.6 (63)	45.3 (43)	64.0(224)	51.9 (353)	52.1 (271)	38.4 (15)	25.0 (35)	31.1 (19)	72.1 (202)
Grass Forbs	13.8 (8)	17.5 (31)	10.5 (10)	6.6 (23)	10.6 (72)	13.5 (70)	0	22.9 (32)	18.0 (11)	9.6 (27)
Reed Canary	17.2 (10)	23.7 (42)	15.8 (15)	13.7 (48)	16.9 (115)	9.2 (48)	5.1 (2)	8.6 (12)	4.9 (3)	11.1 (31)
Midland	6.9 (4)	8.5 (15)	5.3 (5)	7.4 (26)	7.4 (50)	13.8 (72)	35.9 (14)	30.9 (43)	16.4 (10)	1.8 (5)
Upland	8.6 (5)	6.2 (11)	18.9 (18)	1.2 (4)	5.6 (38)	4.0 (21)	12.8 (5)	2.9 (4)	19.7 (12)	0
Prairie Hay	3.4 (2)	2.8 (5)	3.2 (3)	0	1.5 (10)	2.9 (16)	7.7 (3)	5.7 (8)	8.2 (5)	0
Quackgrass	10.3 (6)	5.6 (10)	1.1 (1)	7.1 (25)	6.2 (42)	4.2 (22)	0	4.3 (6)	1.6 (1)	5.4 (15)
Edge type	2.6 (16)	14.6(101)	6.9 (31)	1.0 (5)	6.8 (153)	6.6 (91)	3.4 (11)	15.1 (56)	4.5 (15)	2.5 (9)
Fencelines	81.3 (13)	72.3 (73)	61.3 (19)	80.0 (4)	71.3 (109)	57.8 (52)	36.4 (4)	69.6 (39)	46.7 (7)	22.2 (2)
Railroad	6.3 (1)	16.8 (17)	16.1 (5)	20.0 (1)	17.0 (24)	31.9 (29)	54.5 (6)	23.2 (13)	53.3 (8)	22.2 (2)
Upland Shrub	12.5 (2)	10.9 (11)	22.5 (7)	0	9.2 (20)	11.0 (10)	9.1 (1)	7.1 (4)	0	55.6 (5)
Trees & edges	6.1 (38)	15.7(109)	10.6 (48)	2.3 (12)	9.0 (207)	7.8 (108)	4.3 (14)	17.0 (63)	5.7 (19)	3.4 (12)
Shelterbelts	18.4 (7)	28.4 (31)	12.5 (6)	0	43.5 (44)	75.9 (82)	64.3 (9)	85.7 (54)	63.2 (12)	58.3 (7)
Sandhills	47.4 (18)	17.4 (19)	50.0 (24)	100.0 (12)	35.3 (73)	14.8 (16)	28.6 (4)	6.3 (4)	21.1 (4)	33.3 (4)
Tree(s)	34.2 (13)	54.1 (59)	37.5 (18)	0	43.5 (90)	9.3 (10)	7.1 (1)	7.9 (5)	15.8 (3)	8.3 (1)
Shrubs	1.9 (12)	10.2 (71)	6.7 (30)	11.8 (62)	7.6 (175)	2.7 (37)	1.6 (5)	4.1 (15)	0.3 (1)	4.5 (16)
Snowberry	58.3 (7)	39.4 (28)	86.7 (26)	95.2 (59)	68.6 (120)	59.5 (22)	0	40.0 (6)	0	100.0 (16)
Misc Shrubs	41.7 (5)	42.6 (30)	13.4 (4)	3.2 (2)	23.4 (41)	16.2 (6)	20.0 (1)	26.7 (4)	100.0 (1)	0
Shrub Grass	0	18.3 (13)	0	1.6 (1)	8.0 (14)	24.3 (9)	80.0 (4)	33.4 (5)	0	0
Forbs	0.5 (3)	1.2 (8)	0.7 (3)	7.6 (40)	2.4 (54)	0.1 (1)	0	0.3 (1)	0	0
Misc Forbs	100.0 (3)	87.5 (7)	33.3 (1)	27.5 (11)	40.7 (22)	0	0	0	0	0
Sweet Clover	0	12.5 (1)	66.6 (2)	72.5 (29)	59.3 (32)	100.0 (1)	0	100.0 (1)	0	0
Wetland	3.3 (2)	0.9 (6)	1.6 (7)	6.7 (35)	2.2 (50)	0.9 (12)	0.3 (1)	0.8 (3)	0.3 (1)	2.0 (7)
Other	0.3 (2)	1.0 (7)	1.8 (8)	0.2 (1)	0.8 (18)	0.7 (10)	0	1.1 (4)	0.6 (2)	1.1 (4)
Total	100.0(622)	100.0(694)	100.0(451)	100.0(525)	100.0(2292)	100.0(1382)	100.0(320)	100.0(370)	100.0(335)	100.0(357)

to the bean field, a move which was precipitated by snow covering the waste sunflower heads. Other radioed birds made similar shifts and all were associated with snow which covered existing feeding areas. Most feeding activities were associated with wind exposed ground or "black dirt" areas in the fields. These areas were used for feeding until food was used up or became snow covered.

Availablity of food was not determined by the acreage, but by the terrain as it influenced movement of snow in exposing waste grain. Several radioed birds and a flock of 31 fed in an oats field in early winter; observations suggest they fed on clover used as a nurse crop and not the grain. When snow eventually covered this source of food, these birds shifted to a nearby windblown corn field that had been used infrequently.

One exception was noted to deep unblown snow causing prairie chickens to abandon a feeding area. This occurred in a corn field completely covered with snow, but regularly used by deer (Odocoileus virginianus). Radioed and non-radioed prairie chickens used this field for feeding on a daily basis in early January and fed where deer had pawed through the deeper snow (10-15 cm) exposing the ground and leaving kernels of corn as a result of their feeding. When the deer stopped using this particular field, so did the prairie chickens.

Local ranchers reported that in tough winters prairie chickens make regular use of their open corn cribs and feed lots. During this study radioed birds were observed feeding on a corn

crib on six separate occasions in midwinter. One rancher reported morning and evening feeding by both prairie chickens and sharptails on his crib through the winter. Observations always showed tracks after fresh snow, and it is estimated that this crib was used by 20-30 prairie chickens and sharptails all winter. When the snows melted in February the use stopped, but the birds returned with the snow in early March. Feedlots with cattle were not used in 1984-85, but silage piles left in the fields were used for feeding by several radioed birds. How much of a role the corn cribs or feedlots play in winter survival is unknown, but during a winter with deep crusted snows they could be important sources of winter food. The practice of grazing cattle in the corn fields in the fall eliminates some food, but the feeding activities of cattle also exposes cobs and scatters kernels making them available to prairie chickens. Cattle manure in these fields contained large numbers of corn kernels, but cold temperatures made them difficult to remove. Prairie chickens were not observed feeding at manure piles, but tracks indicated that they do occasionaly visit them. In central Wisconsin corn piled on wooden platforms is used to provide prairie chickens with winter food when the corn crop fails or deer destroy food patches.

Analysis of habitat use must consider that use varies with time of day (Fig. 15). Use of agriculture by prairie chickens occurred primarily during the AM and PM and was associated with feeding and loafing. Fig. 16 shows the incidence of various

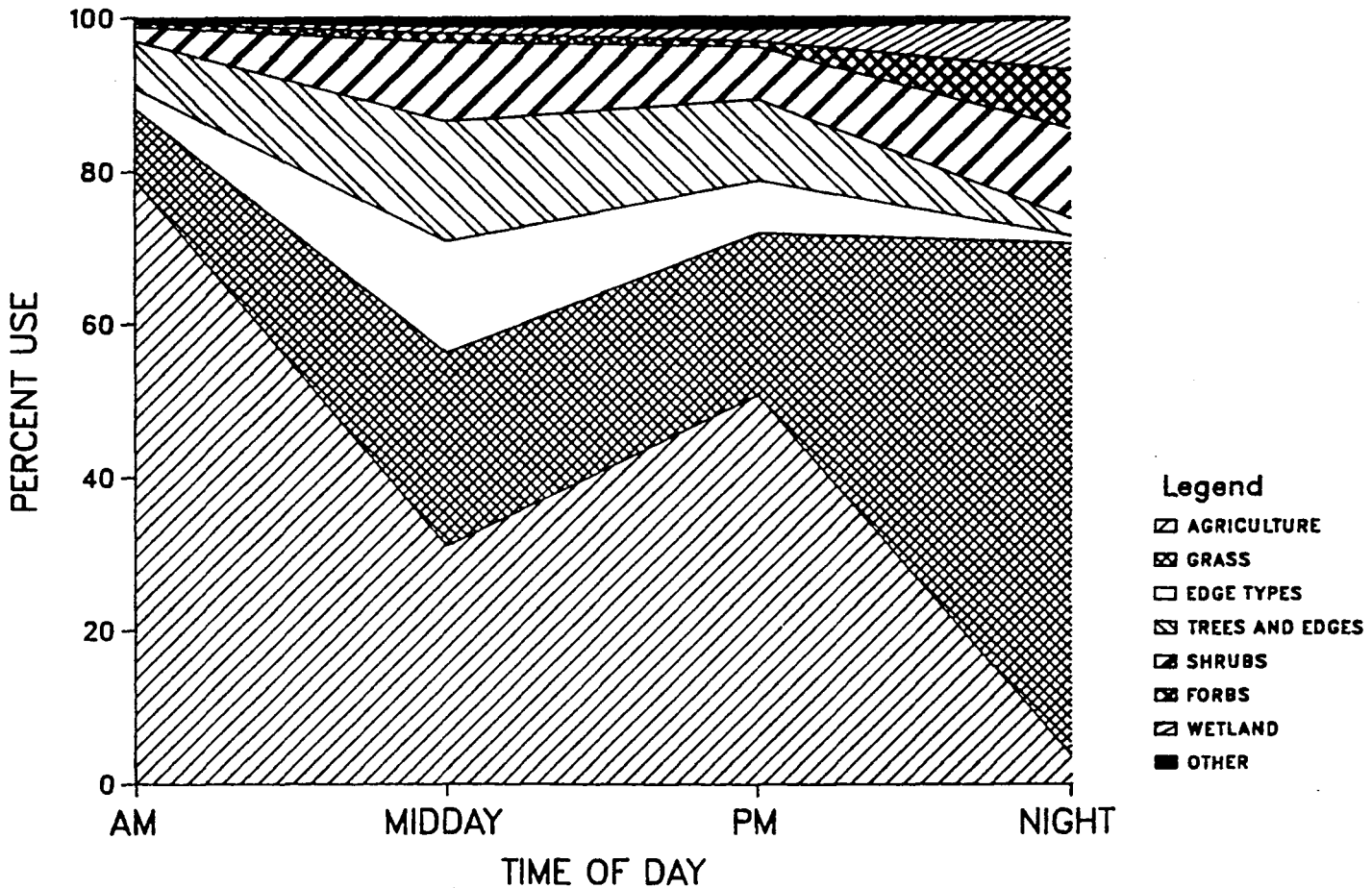

Fig. 15. Use of habitat types by time of day for radio-tagged prairie chickens during winter, (15 December to 17 February), Sheyenne National Grasslands, 1984-85.

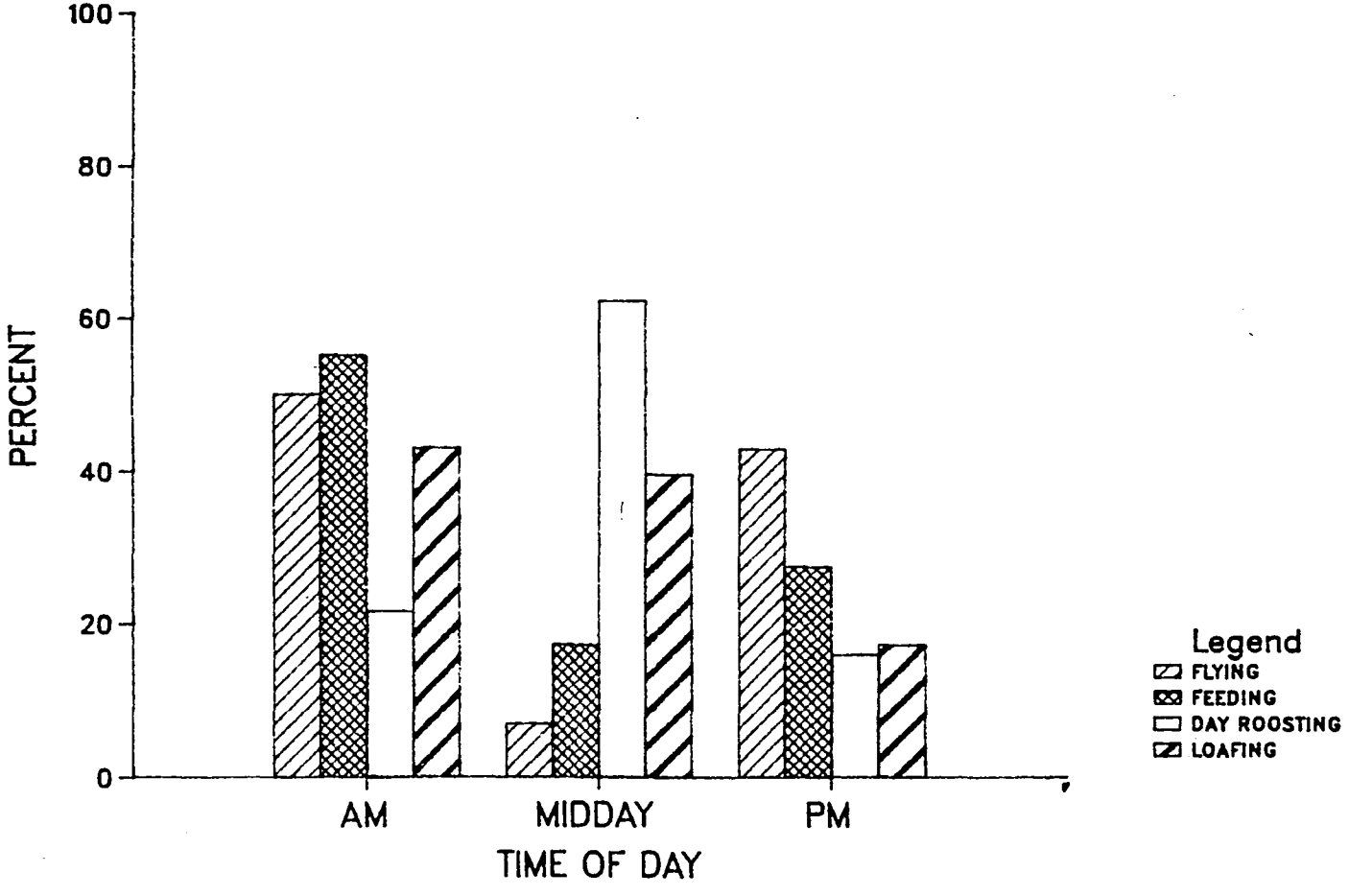

Fig. 16. Distribution of observed activity by time of day for prairie chickens during winter, (15 December to 17 February) Sheyenne National Grasslands, 1984-85.

activities during the three daylight time periods. Appendix Table 10 identifies activity with habitat types.

The habitat used for night roosting is dramatically different from daytime use as there is a complete shift away from the agricultural habitat types. Night roosting occasionally occurred in agriculture, but was not common (Table 4). The majority of night locations, 66.7 % occurred in grassland followed by shrubs, 11.8 % and wetlands at 6.7 %. (Table 4). The lowlands recieved the greatest use (64.0 %) followed by reed canary (13.7 %) midland grasses, primarily little bluestem (7.4 %) and quackgrass (Andropyron repens) (7.1 %). All of these grasses are tall in form, and stand up well against winter conditions. The short forms of upland grasses and prairie hay were used sparingly. Almost all of the shrub use occurred in snowberry (95.2 %). Other shrubs used were willow and Spirea sp. Tree edges were used at night, but not often. The use that did occur was by one radioed hen which frequented the sandhills. Examination of her roosts in this area showed that she was not under the trees, but was snow burrowing in snowberry along the edge or in deep snow drifts (with no cover) in gulleys where 1-2 m of snow had accumulated.

The reduced occurrence of the edge types recorded at night locations is a function of the methods used. During the day locations made by triangulations did not permit precise identification of habitat types for birds in the proximity of two types. However at night, 79 % of all radioed birds were located

by driving or walking within 20 to 30 m of their roost site; these areas were marked and the actual habitat type observed, usually the next day.

Limited observations indicated that some feeding did occur away from the agricultural areas. Tracks in snow indicated feeding in the grassland at patches of forbs, snowberry and rose (Rosa sp.) before and after visiting agriculture. Manske and Barker (1981) reported budding in shelter belts on the SNG in 1980. In this study budding in trees was rarely observed (Appendix Table 10). The primary use of trees appeared to be for loafing before the birds moved into or after they left the agricultural fields. How much these nonagricultural foods were utilized is not known and will be better determined from the analysis of fecal droppings collected from birds roosting with the radioed individuals. The main food source on the SNG for prairie chickens in winter is provided by agriculture on private land. There is no agricultural land on the SNG public land.

Height. Of all the radio locations in winter, 88 % were associated with Class III or taller vegetation (26 cm or greater). Class III vegetation (25 to 50 cm) dominates the usage at 69.9 %. The pattern of use, like that for habitat type, varies between the periods of the day (Fig. 17). The shorter forms, Class I and II (less than 25 cm) were used primarily during the AM (51.4 %) with slightly lower use during the PM (47.2 %). The taller Classes (III and IV) were used for day roosting during the midday period (59.6 %). Robel et al. (1970a)

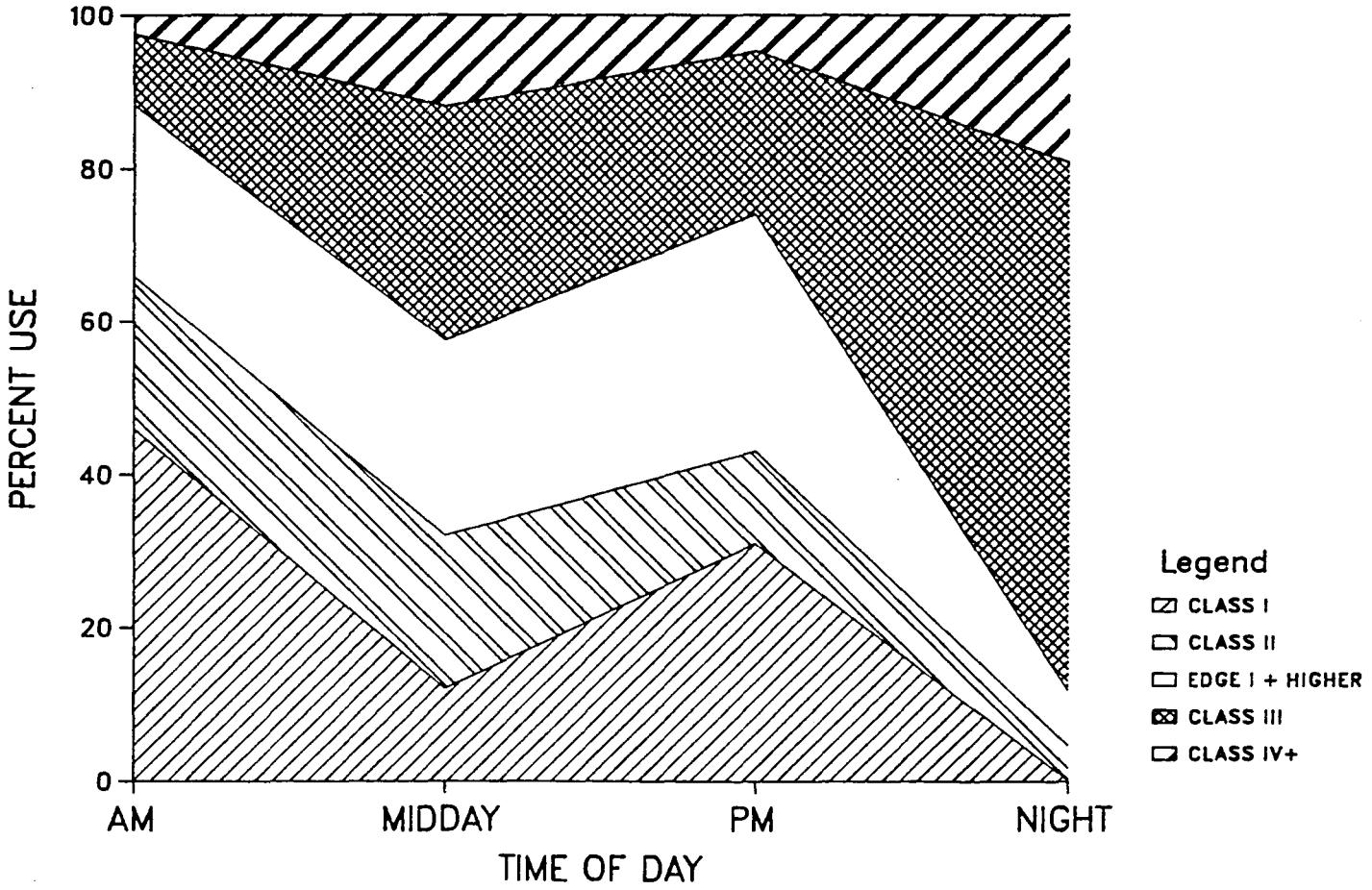

Fig. 17. Use of vegetation height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV+ greater than 50 cm) by time of day for radio-tagged prairie chickens during winter, (15 December to 17 February), Sheyenne National Grasslands, 1984-85.

indicated that density (visual obstruction) was not a "significant factor in habitat usage in prairie chickens". However, their density data were collected from vegetation transects and not from the specific sites used by prairie chickens. Most other researchers have pointed out, the importance of taller undisturbed cover (Hamerstrom and Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al. 1957, Horak, 1985).

The edge habitats between shorter and taller vegetation classes were used equally through the day. This edge type was important and probably used more than our data indicates as it provided proximity to cover with simultaneous access to two vegetation forms. This occurred along the borders of agricultural fields, and edges between lowland and upland and upland and midland grasses. Hamerstrom and Hamerstrom (1949), and Jones (1963) also reported the use of fenceline cover for day roosting and loafing. Activity recorded by time of day showed that feeding was observed most in the lower height classes, particularly Class I (76.1 %). Day roosting was primarily associated with Classes III and IV (greater than 25 cm), with most occurring in Class III (55.3 %). The high indicated use of the lower classes reflected the bias that activity must be observed to be documented and birds were more easily seen in the shorter vegetation types. However, telemetry data showed the same general pattern of use and indicated that birds are most active, primarily feeding in the AM and PM (Appendix Table 11). The day roosting observations

were based on birds flushed or examination of sign after birds moved and is thought to accurately represent day roosting habitat and height use. The increase in use of the taller classes during the PM period reflected the behavior of prairie chickens going to roost early during periods of cold weather.

Disturbance. It is important to know which land uses created specific habitat types and conditions as it indicates how management can direct its efforts to create habitat necessary to maintain a population. Disturbance has its greatest influence on vegetation height. The taller height classes were used the most by prairie chickens, yet shorter forms were used for feeding. A mixture of tall and short, i. e. undisturbed and disturbed, is an important aspect of prairie chicken habitat. The amount and distribution of each will strongly influence the number of prairie chickens in a given area. Excessive disturbed short vegetation will reduce the amounts available for roosting and nesting. What the effect of "too much tall" undisturbed vegetation would have is not known, but without regular disturbance, vegetation will become rank and be used less. Regular disturbances will also prevent invasion of open grasslands by shrubs and woodlands. The most difficult component of prairie chicken habitat to maintain is the undisturbed open grassland, since this is the type of habitat most commonly converted to cropland or pastureland.

The use by prairie chickens of disturbed or undisturbed habitat varied during the day and showed a strong similarity in

the pattern of use to the type and height data. Disturbed agricultural areas were used most during the AM (82 %) and PM (58.5 %)(Fig. 18), primarily for feeding (Appendix Table12). This high use of the disturbed areas was a function of the high use of agricultural habitats with their shorter height classes and reflected a concentration of available food. Open low vegetation provided easier access to food on the ground and agricultural activities increased both the distribution and amount present. This use of disturbed areas has also been reported by (Yeatter 1943, Ammann 1957, and Drobney and Sparrowe 1977).

Standing corn though of a taller class also provides access to food above the snow. There were only two known areas of standing corn on the SNG in winter 1984-85. Although no radioed birds used them, observations of tracks and birds in the area indicated that both were used by prairie chickens, sharptails and deer. One which consisted of only a couple of rows of corn in a low area was cleaned out by early January, apparently causing the birds to shift to an adjacent picked corn field. The other field was approximately 2 acres in size and was used by feeding grouse and deer all winter.

Use of undisturbed cover was highest at night (77.9 %, Fig. 18). Unmowed lowlands (38.7 %) and lightly grazed lowlands were used most often at night for roosting. These lowland areas were dominated by Panicum spp. and Carex spp. Hamerstrom et al. (1957) suggested that prairie chickens when night roosting have a preference for grass and sedges over woody cover. Snowberry was

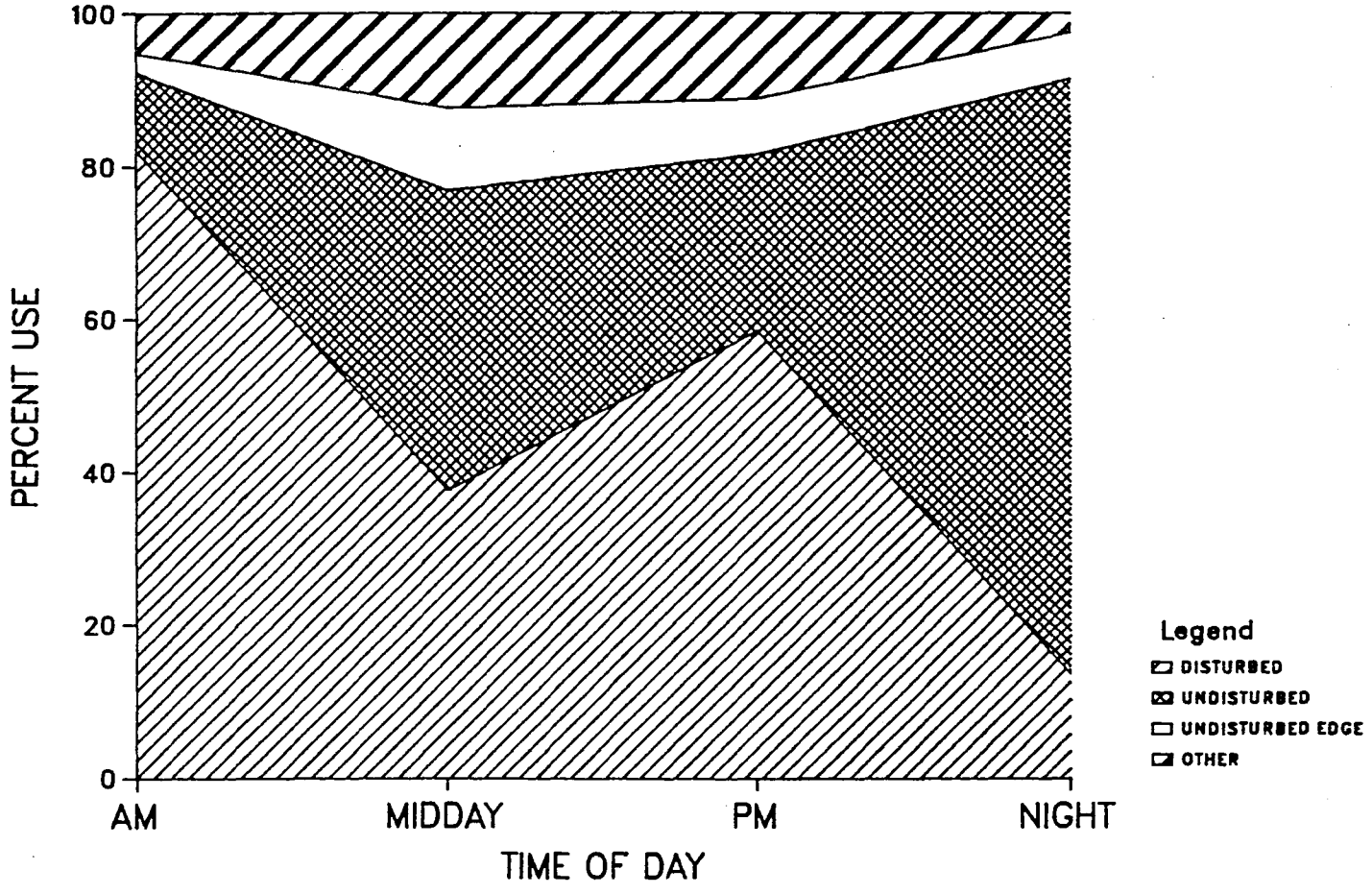

Fig. 18. Use of habitat disturbance types by time of day for radio-tagged prairie chickens during winter, (15 December to 17 February), Sheyenne National Grasslands, 1984-85.

used 11.2 % and classified as undisturbed even though areas between stems were heavily grazed. The stucture and height created by snowberry was similar to undisturbed grassland. Snowberry was used by prairie chickens only for snow roosting, as it trapped snow deep enough to permit burrowing.

All of the unmowed lowlands were lightly grazed since cattle were put in all pastures at sometime during the grazing season. These lowlands were also classified as undisturbed as use of the unmowed lowlands by cattle on the SNG rarely reduced structure; and when it did the area was classified as grazed. By contrast mowing of lowlands in the summer eliminated all structural cover from these areas until the following June. It is this growing vegetation in the lowlands that is often used by hens with broods (See Phase I). A mowed reed canarygrass area located on private land was used for night roosting. This area was mowed in early July, although regrowth provided cover of 10-15 cm in height in late December.

Use of Pastures. Use of pasture types by prairie chickens is presented in Table 5. No obvious difference was apparent in total use of the deferred and nondeferred pastures in the winter. The deferred pastures, because of less cattle use during the growing seasons contained more and taller vegetation and received slightly higher use at night. However, tall cover was not restricted to deferred pastures as all pastures, except those where the lowlands were mowed, provided potential roosting habitat. The amount varied between pastures as almost all grazing

Table 5. Use of pasture type by time of day (%) for radio-tagged prairie chickens, winter (15 December to 17 February) and early spring (18 February to 15 March), Sheyenne Grasslands, North Dakota, 1984-1985. Number of locations in parentheses.

	Winter					Early Spring				
	Time of Day						Time of Day			
Pasture Type	AM	Midday	PM	Night	Total	Total	AM	Midday	PM	Night
Deferred	28.0 (21)	36.5 (65)	35.8 (48)	43.6(190)	40.9(324)	72.1(511)	81.0 (73)	39.5 (34)	86.0(136)	71.5(268)
Nondeferred	42.7 (32)	41.0 (73)	50.7 (68)	34.5(148)	40.5(321)	14.4(102)	23.8 (10)	12.8 (16)	19.6 (11)	26.7 (65)
Continuious	6.7 (5)	2.8 (5)	2.2 (3)	6.4 (28)	5.2 (41)	6.6 (47)	9.5 (4)	12.0 (15)	7.1 (4)	9.9 (24)
Private	8.0 (6)	9.6 (17)	6.0 (8)	14.6 (64)	8.1 (95)	3.8 (27)	0	6.4 (8)	3.6 (2)	7.0 (17)
Sandhills	14.7 (11)	10.1 (18)	5.2 (7)	1.4 (6)	5.3 (42)	3.1 (22)	7.1 (3)	10.4 (13)	8.9 (5)	0.4 (1)
Total	100.0 (75)	100.0 (78)	100.0(134)	100.0(430)	100.0(822)	100.0(709)	100.0(90)	100.0 (86)	100.0(158)	100.0(375)

units were managed differently. Continuiously grazed pastures received little use by prairie chickens in winter and reflected the greater reduction in vegetation height.

Landownership. Prairie chicken habitat use based on landownership shows that 76.4 % of all radio locations occurred on private land (Appendix Table 13). This was due primarily to the high use (52.9 %) of agriculture during the day. Night roosting favored public land (56.2 % versus 43.8 %). The use of private and public land emphasized the importance of both to the winter survival of the prairie chickens on the SNG. The recorded use of private land for roosting was the result of two radioed prairie chickens that used private lands for both feeding and roosting. The roosting areas like those on SNG were lowland pasture areas that were undisturbed, Class III and IV vegetation. This type of habitat was not common on private land. The typical pattern of 17 of 20 radioed birds was to feed on private agricultural land and roost at night on public land.

Early Spring

General habitat use relative to type, height and disturbance patterns in the early spring were only slightly different from those observed during the winter. The use of grass increased from 29.6 in winter to 37.6 % in the early spring. The use of the edge types remained the same and the use of shrubs declined (Table 4). Changes in the daily pattern of habitat use occurred in the PM period, where the incidence of agriculture increases from 50.8 % in the winter to 70.4 % in the spring. The use of the lower height classes in the PM also increased in early spring (63.1 % versus 81.7%) as did the use of disturbed habitat (58.5 versus 77.3 %). These changes were the result of longer warmer days and prairie chickens spent more time feeding in the PM.

Night roosting habitat use patterns in spring were similar to those in winter, the lowlands and Class III vegetation still dominated (71.66 %). Overall use by land ownership remained the same except for the reduction in use of public land in PM period. This was also due to the longer feeding periods in agriculture in the PM (Appendix Tables 10 & 13).

Within the agricultural types the use of alfalfa and sunflowers increased from winter to spring from 3.6 to 20.1 % and from 8 to 18.2 % respectively. The disapearance of snow made the food in these two types available. It is believed that prairie chickens have a preference for sunflowers as birds with both corn and sunflowers in the same feeding field, fed in the sunflowers.

In winter sunflowers were only available where snow was blown clear.

Alfalfa was used for both feeding and roosting in the spring. The alfalfa fields used for roosting (both day and night) were the fields where only two crops of hay were taken and regrowth in late summer produced cover of 8 to 15 cm. Short-cropped alfalfa was used for feeding as the growing green vegetation was apparently attractive to prairie chickens, particularly hens.

The use of pasture type shifted to the deferred pastures in the early spring (Table 5). This shift is thought to be biased by the daily use of a single deferred pasture by three radioed hens which centered their activity in this pasture and a corn field along its border. Other radioed birds showed no decided shift to the deferred pastures in areas where both were available.

The winter and early spring habitat data presented here should not be taken out of context. The high use of agriculture is obvious and important to the survival of the prairie chicken on the SNG, but it must be related to the prairie chickens year-long requirements. One cannot managed solely for winter habitat or nesting and brood rearing habitat. Management must provide a combination of agriculture and grass that will provide the necessary seasonal requirements. The grass component must be of the right height and type for nesting and roosting, yet in proximity to winter food. From early spring on there is a decided decrease in the use of agriculture and a corresponding

increase in the use of grassland. Over 70 % of all nests and over 90 % of all booming grounds were located on the public grasslands. Although this phase of the study is concerned primarily with winter habitat use, a decided change in use was noted between winter and late spring. Habitat use by type, height class disturbance and landownership on a weekly basis, by day and night, are presented in Figures 19 through 26. From early April on, a decided shift in habitat use during the day was recorded, from agriculture to grassland. Night roosting continued to be centered in the undisturbed lowlands.

Summary Daily Pattern

The daily tracking of radioed individuals, along with observations in the field, yielded the following general pattern for winter daily movements and habitat use by prairie chickens on the SNG. Prairie chickens left the roost area in small flocks, after sunrise, flew 0.8 to 1.6 km (0.5 to 1 mile) to agriculture, where they fed and loafed in low form (Class I or II, 0 - 25 cm) disturbed vegetation, primarily picked corn. They walked or flew 0.8 to 1.6 km to taller, (Class III, 26-50 cm) undisturbed vegetation, where they loafed or day roosted during the midday. They returned to short form, disturbed vegetation in the PM, fed and then flew to taller (Class III or IV, 26 - 50+ cm) undisturbed lowlands or snowberry to night roost. Prairie chickens typically made four major flights of over .4 km (.25 mile) per day, one from roosting to feeding, one to the day roost

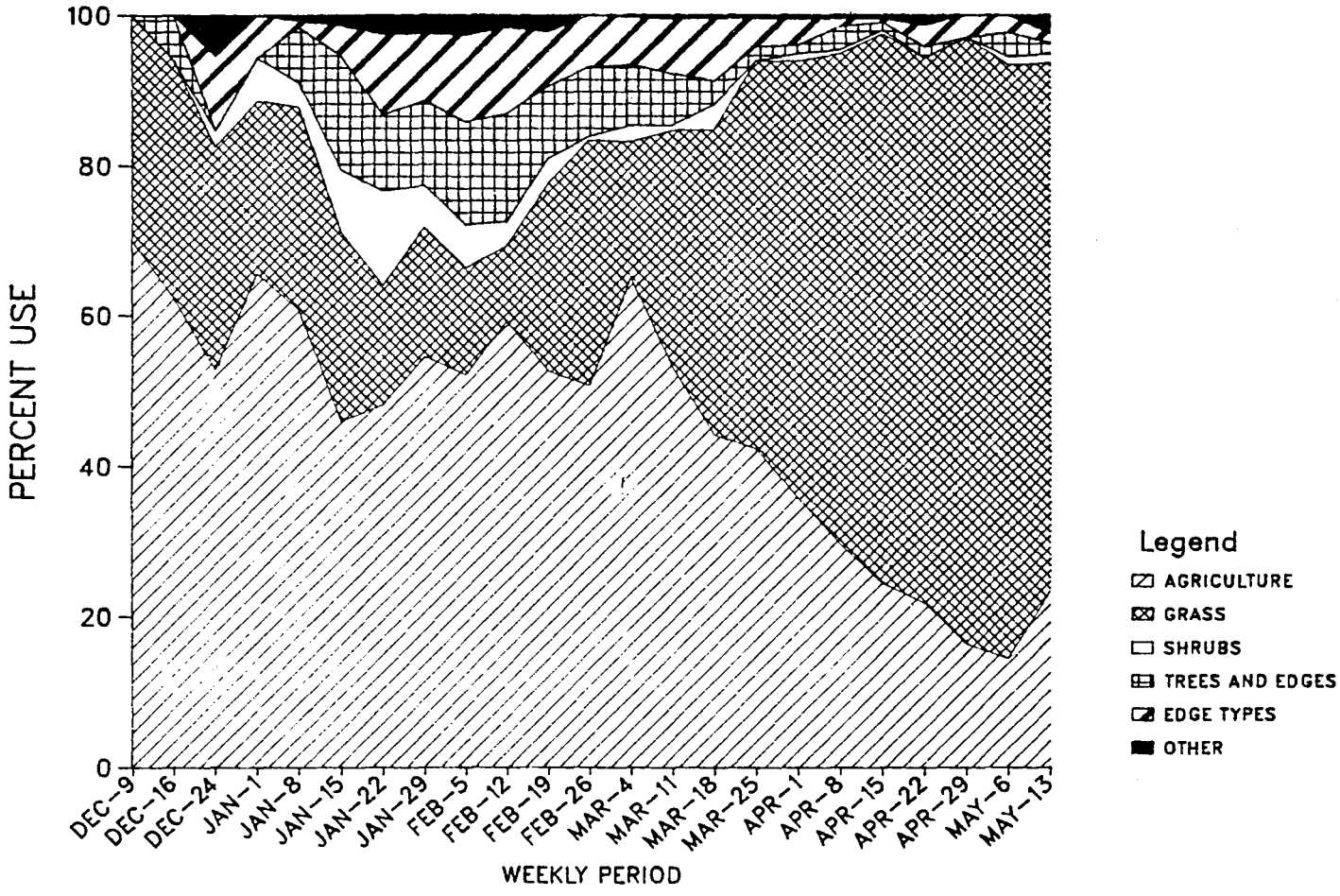

Fig. 19. Weekly use of habitat types during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

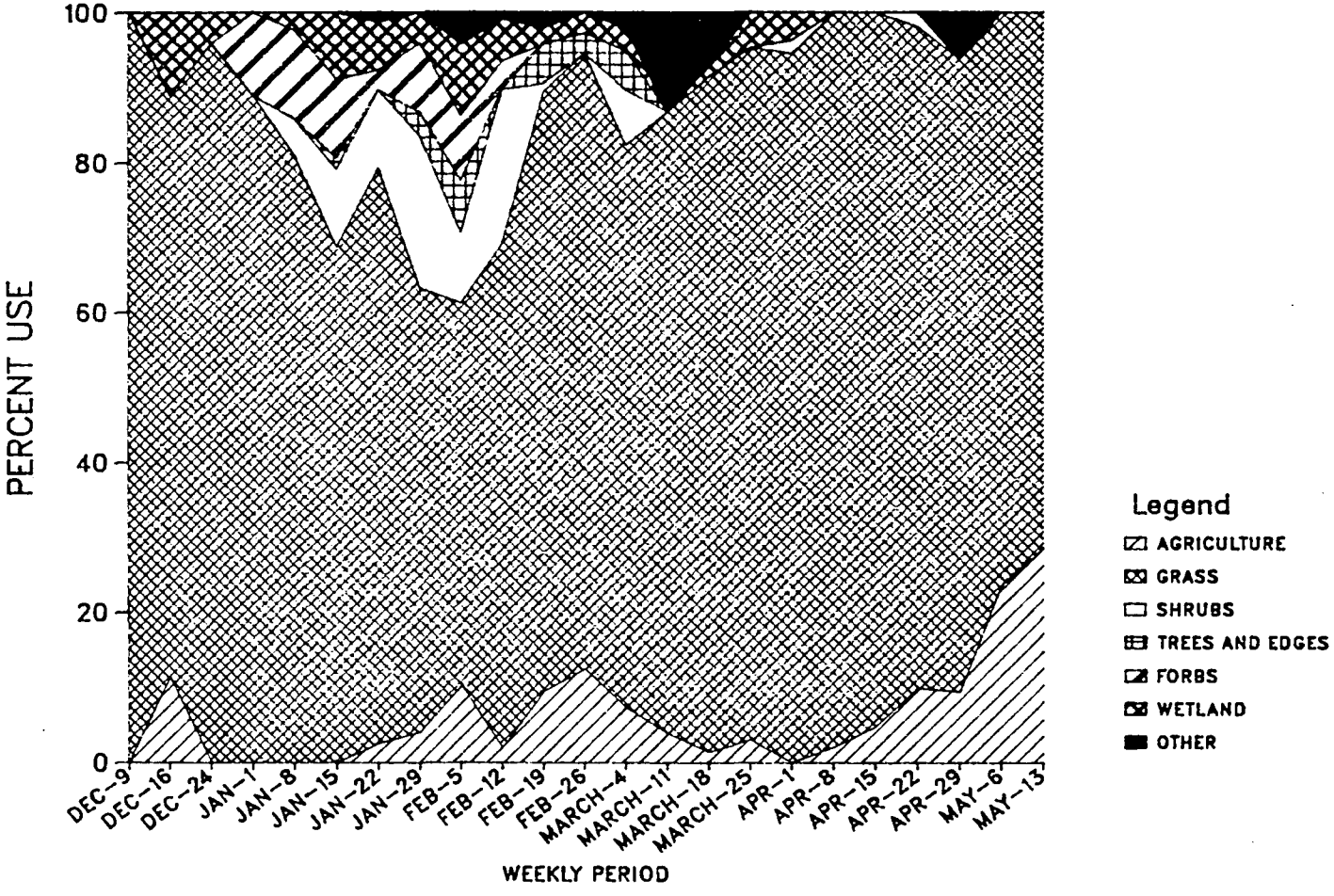

Fig. 20. Weekly use of habitat types at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

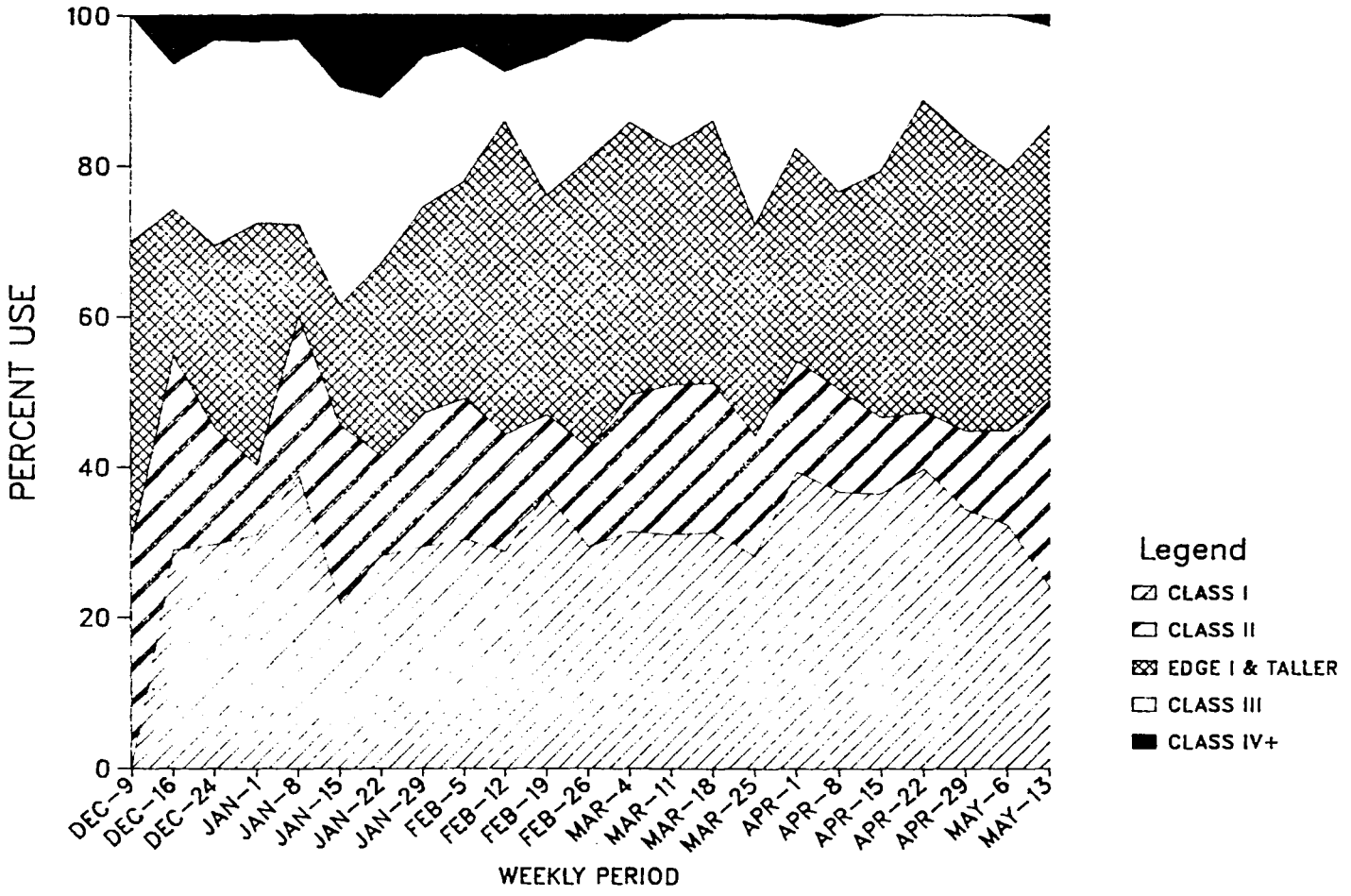

Fig. 21. Weekly use of vegetation height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV+=50+ cm) during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

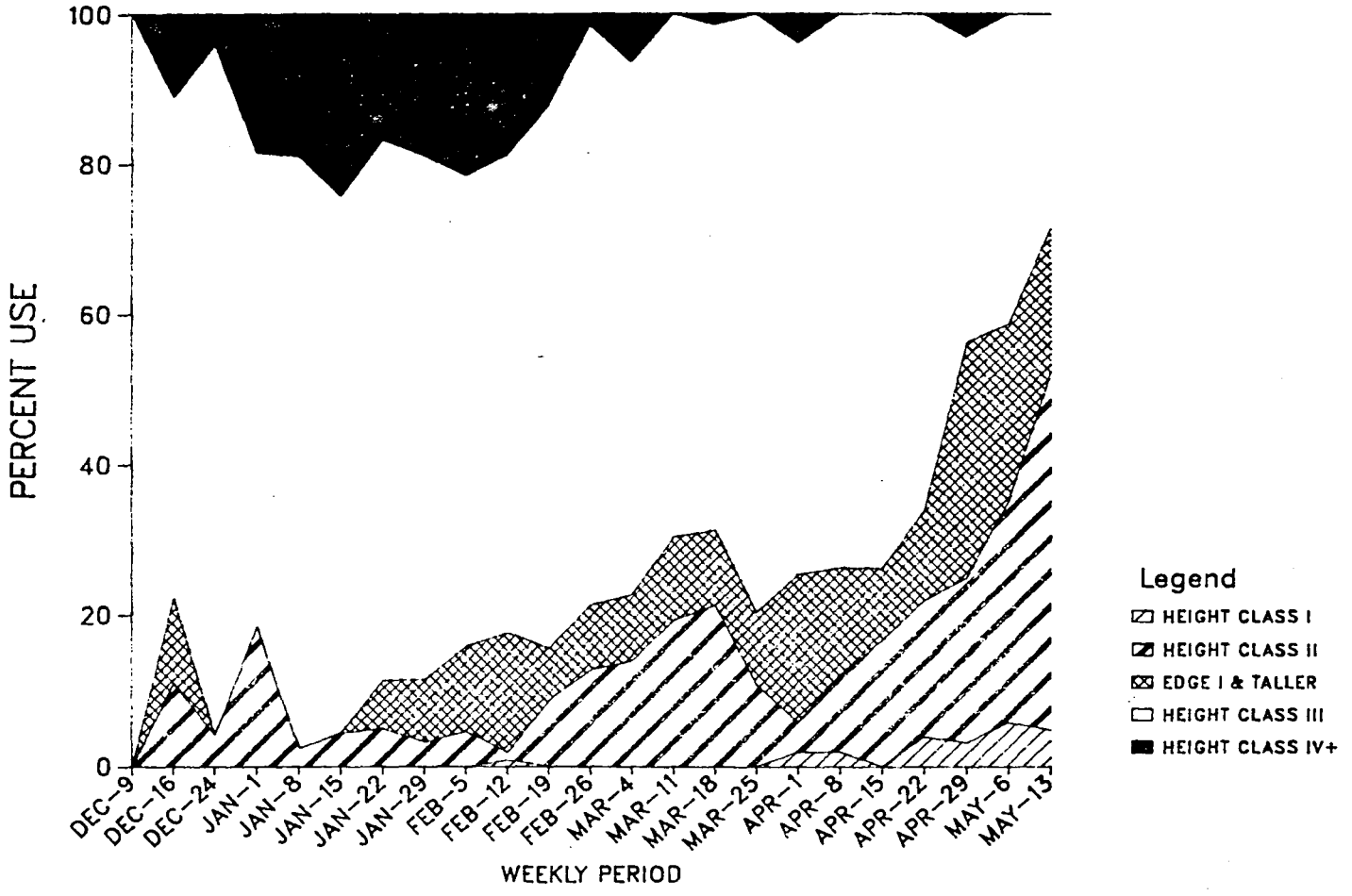

Fig. 22. Weekly use of vegetation height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV+=50+ cm) at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

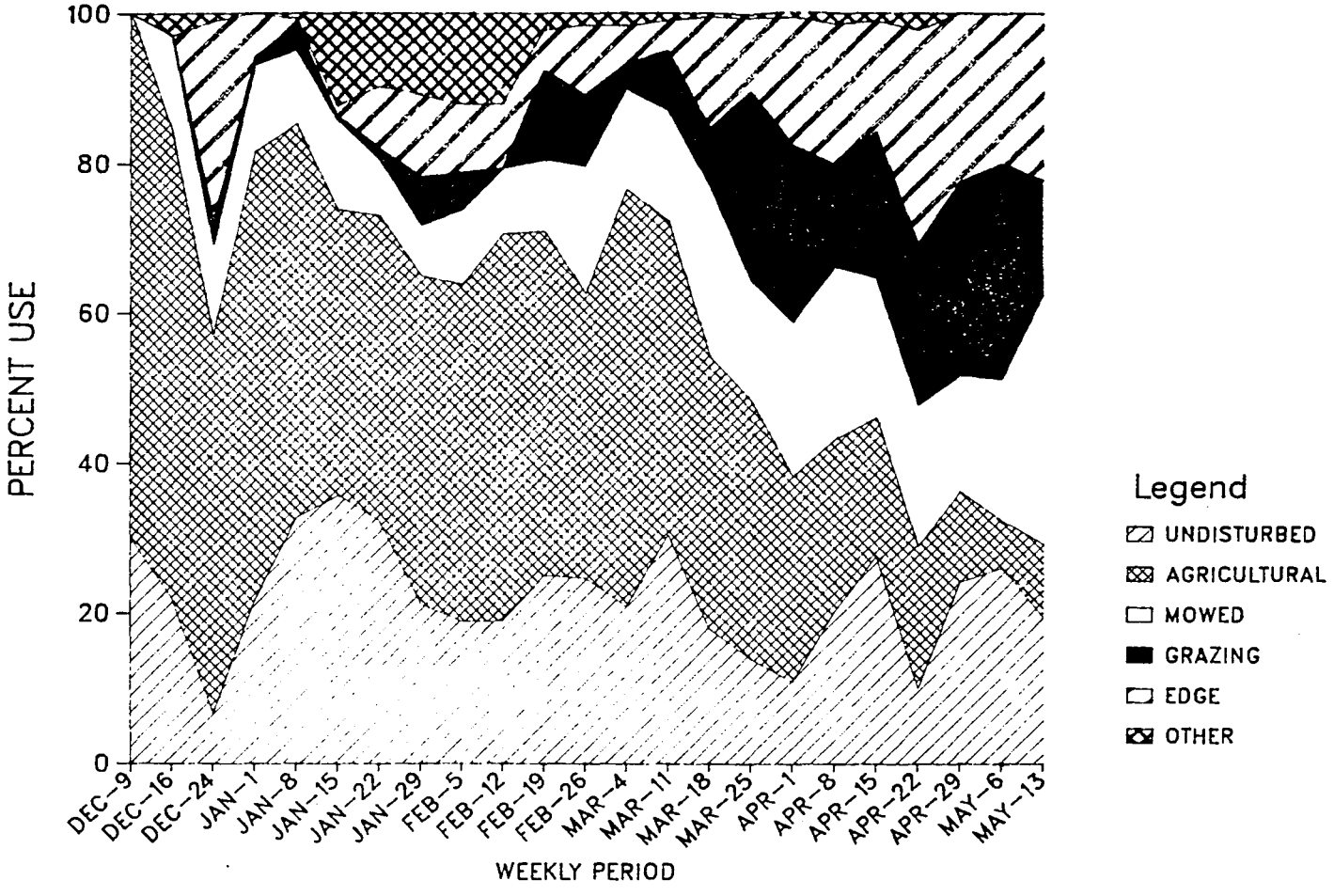

Fig. 23. Weekly use of disturbance types during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 1984-85.

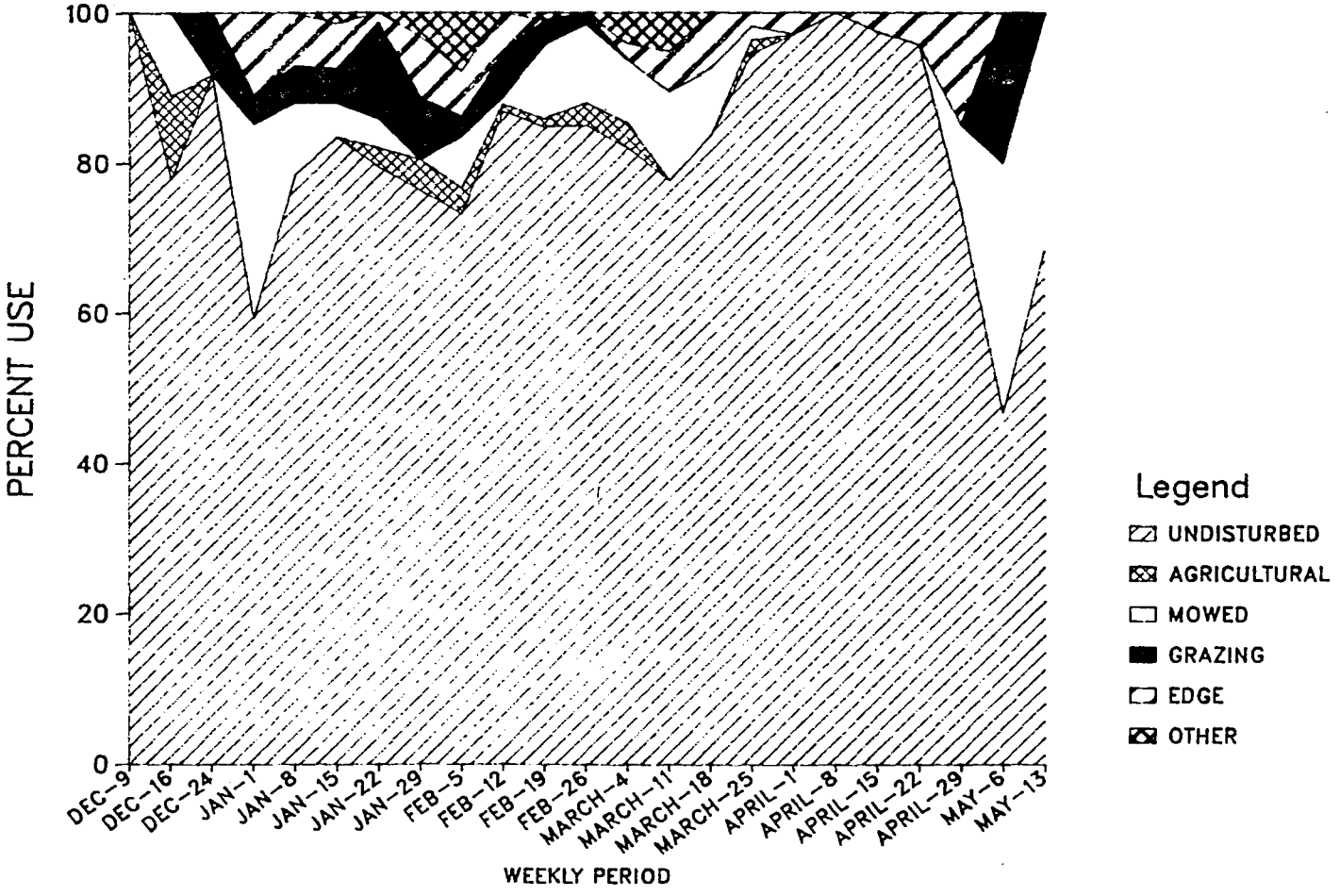

Fig. 24. Weekly use of disturbance types at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

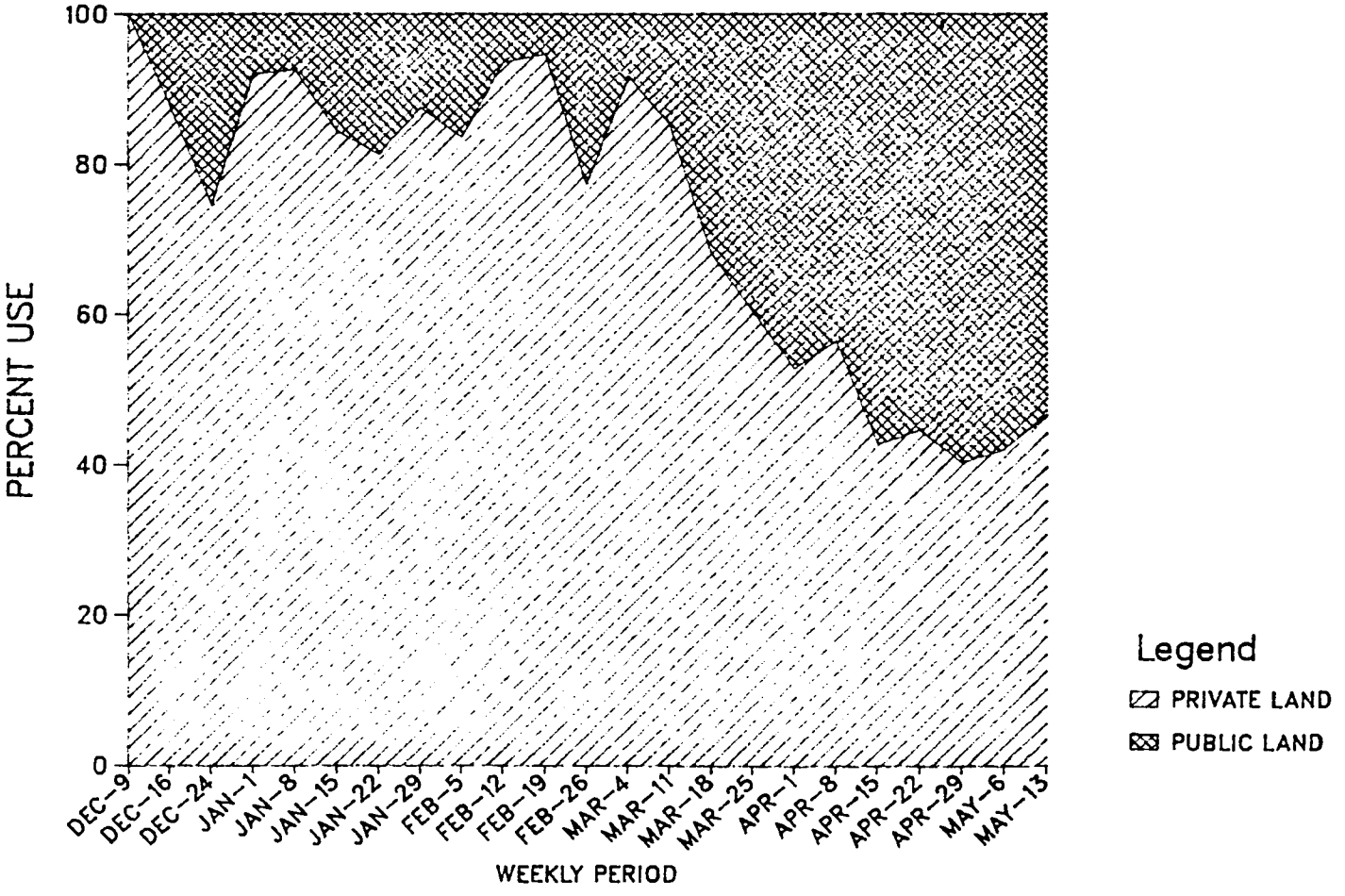

Fig. 25. Weekly use of land types by landownership during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

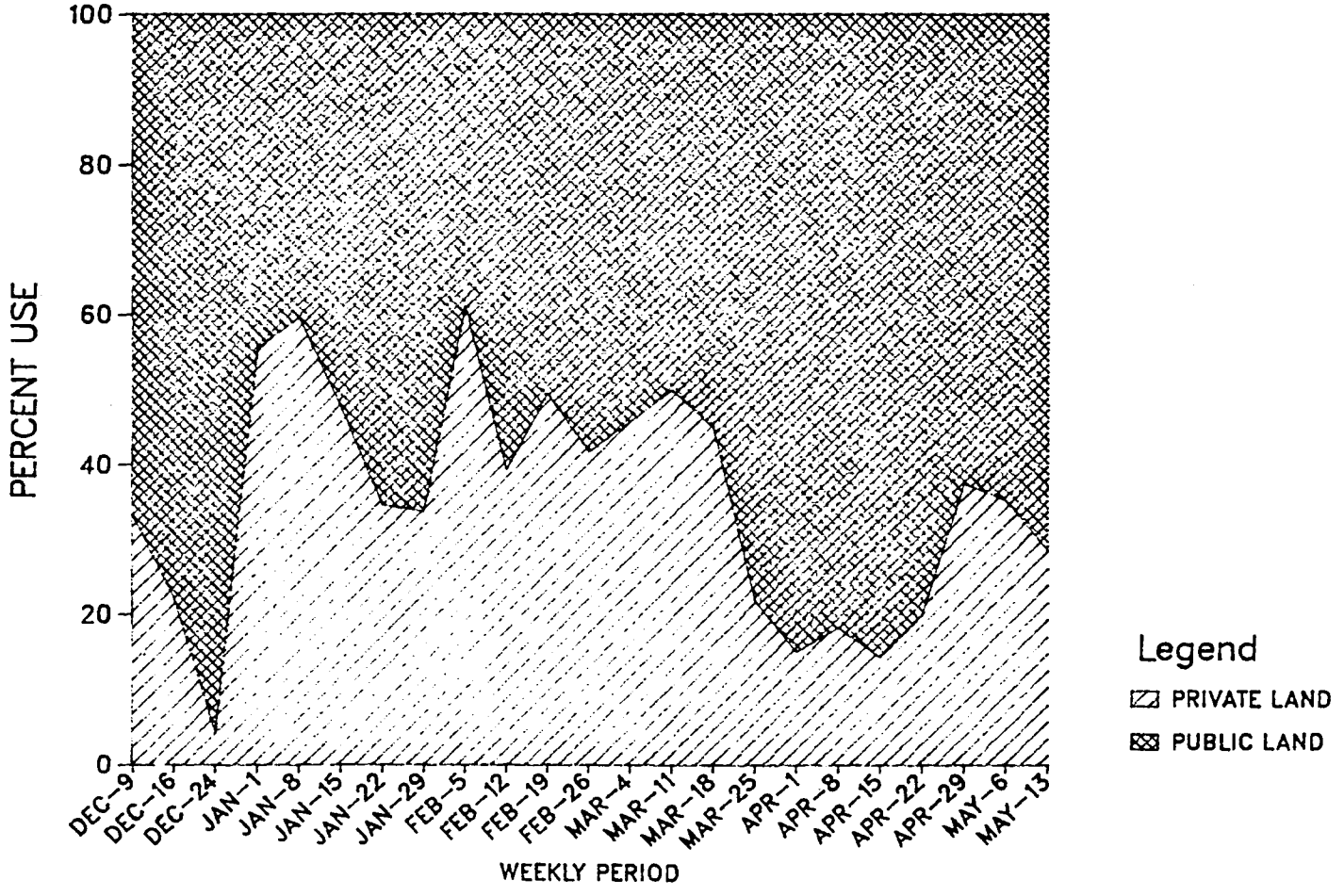

Fig. 26. Weekly use of land types by landownership at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December to 13 May, 1984-85.

areas, one back to the feeding area and a final flight to a roosting area. Flights to feeding and roosting areas were often made in two segments, one long and one short, making six flights a day. At times prairie chickens made additional flights during the day to visit other feeding or day roosting areas. Changes in the daily pattern usually occurred when new snow covered regular feeding areas, or when sub-zero temperatures caused them to spend more time in the roost. Once prairie chickens established a feeding pattern in the winter they tended to follow it until conditions changed. This pattern changed for the cocks in late winter as they initiated visits to their booming grounds early in the morning before they fed. Hens reduced their movements and localized near a food source. As spring progressed cocks also visited booming grounds in the morning and evening, and eventually abandoned agriculture and began to feed in the grasslands near their booming grounds.

Although predictable, this daily pattern was influenced by weather, predators and human disturbances. As a result feeding, loafing, flying and display can be observed throughout the day.

Individual Night Roosts

A total of 372 winter and 52 early spring prairie chicken night roosts were examined and analyzed between 12 January and 15 March in 1985. Four types of roosts were documented: a vegetation roost, where vegetation was the only source of cover; a snow depression, where the bird made a bowl in the snow and snow was the main sorce of cover; a snow vegetation-roost where

both vegetation and snow provided cover; and the snow burrow where the bird made a tunnel and enclosed cavity into soft snow.

Snow plays a very important role in roosting in prairie chickens in the winter. Both the accumlation or the movement of snow by wind created situations that influenced roost site selection. With the exception of several snow burrows in the sandhills where the birds burrowed into snow that had accumulated in drifts of up to 2 meters, all observed roosts were associated with some type of vegetation. The vegetation either served as cover or caused snow to accumulate in a snow fence effect, creating deeper snows where the birds could burrow or make a depression. Terrain served a similar function as blown snow accumulated in the lee of the ridges.

Evaluating the cover at individual roost sites was difficult when snow was present, as the birds used both snow and vegetation. Because of the role snow played in providing roost cover, two methods of employing the Robel pole were used to evaluate roosting cover, total coverage and coverage by vegetation. Total coverage included snow and vegetation in reading obstruction on the Robel pole, while coverage by vegetation included vegetation only. Each roost had four Robel pole readings, but some because of snow, had from none to four for vegetation. Many roosts, particularly snow burrows and depressions, had little vegetation above the snow within 0.5 m of their roosts so readings were often for snow only. Some

roosts were not revisited before conditions changed and only those variables not altered by wind or snow were measured.

Dominant Cover. No detailed species composition was collected at individual roost sites, as only the dominant species or genus was visually estimated for each roost. Grasses and sedges were dominant at 74 % of the roosts in winter. Panicum vergatum and Carex lanuginosa and Panicum sp. and Carex sp. either alone or in combination, were dominant at 43.6 % of the observed roosts. Snow burrows were associated with the taller species that trapped and accumulated enough snow to permit the birds to burrow. Snowberry, sweet clover, quackgrass, Panicum spp. and Spartina gracilis, all tall, sturdy species dominated at snow burrows. Appendix Table 14 shows species composition at night roost by roost type.

Thick dense cover was not used for roosting or burrowing as the density of stems prevented entry into the vegetation. Space between stems is necessary to permit birds access to snow, but height and structure are also necessary to hold or accumulate snow. Snowberry and sweetclover (Melilotus spp.) were not important dominants in any other roost types as they provided little cover in the absence of deep snow.

In order to snow burrow the birds had to actively seek out areas where snow had accumlated to the necessary depth. It was not uncommon to observe where birds had attempted to snow burrow only to have it collapse. Snow burrows were unsuccessful either because the snow was too shallow or too soft to support a roof.

The mean depth was 25.2 cm for successful burrows and 22.1 cm for unsuccessful burrows.

The accumlation of snow on the level during the winter 1984-85, never reached the minimum depth necessary for burrowing (Fig 4). All successful burrows were in areas where snow had accumulated due to vegetation or terrain. When a bird failed to burrow it usually walked a short distance and formed a snow depression near some vegetation above the snow. At times both snow burrows and snow depressions were found in the same group of roosting birds. Unused snow depressions were often found in the tracks leading to eventual night roosts. These depressions contained 1-2 or no droppings and appeared to be temporary or possibly even unsatisfactory roosts as birds would leave them and move to a burrow or make another depression farther away. At times some birds must have flown to different sites as no tracks were found leading from the unused depression.

Snow depth at unused depressions was shallower (Table 6) and less vegetation was present at used roosts (Table 7). These depressions may just be loafing forms occupied only until the bird decides to go to roost for the night. These unused depressions are not always present, and at times the bird remained for the night in their first and only depression. Back tracking from night roosts has revealed as many as three such depressions on the way to the final night roost. The mean distance walked in snow to night roosts was 104 m (SD = 84, N = 101). No evidence was found that prairie chickens ever dove from

Table 6. Snow depth by roost type for prairie chicken night roosts and random points, during winter (15 December to 17 February) Sheyenne National Grasslands, North Dakota, 1984-85. Number of roosts in parentheses.

	Depth of Snow (cm)	
Roost Type	At Roost	In Roost
Vegetation	7.5±4.2 (29)	
Vegetation and snow	8.0±6.7 (88)	11.3±5.5 (20)
Snow Depression	22.5±4.1 (76)	17.1±3.9 (91)
Unused Snow Depression	21.1±7.7(114)	15.6±3.8 (27)
Snow Burrow	25.8±7.5(143)	19.8±4.5(130)
Unsuccessful Snow Burrow	22.4±6.3 (38)	16.1±8.0 (7)
Random Points	13.5+9.2(140)	

Table 7. Mean Robel pole readings by total and vegetation coverage for individual prairie chicken night roosts and random points, during winter (15 December - 17 February), and early spring (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985.

	Mean Robel pole reading			
	Total Coverage*	Total Coverage	Coverage by Vegetation	Coverage by Vegetation
Roost Type	Roosts	Random Points	Roosts	Random Point
Vegetation				
Spring	1.6±1.0 (40)	1.2±1.2 (97)	1.6±1.0 (40)	1.2±1.2(97)
Winter	2.1±1.0 (32)	1.5±1.4 (46)	2.1±1.0 (32)	1.5±1.4(46)
Vegetation and snow				
Winter	2.8±1.4(115)	1.7±0.6 (56)	1.1±0.4 (90)	1.5±0.4(38)
Spring	1.9±0.5 (12)	1.3±0.5 (44)	1.9±0.5 (12)	1.3±0.5(44)
Snow Depression	2.1±0.8(120)	1.8±1.1(104)	3.2±0.9 (38)	2.4±1.1(12)
Unused Snow Depression	2.3±0.4 (76)		0 (76)	
Snow Burrow	2.6±0.8(145)	2.4±0.8 (162)	3.8±0.4 (2)	2.8±1.0 (7)
Unsuccessful Snow Burrow	2.2±0.6 (39)		0 (39)	

* Snow or vegetation or a combination of both.

flight into snow burrows. The usual pattern based on tracks was to land in open areas along the edge of vegetation, walk (0.1 to 20 m) into cover and select a roost site. In the morning birds either flew directly from their roosts or walked a short distance and flew. Tracks indicated that birds did little feeding in roost areas in the morning, although some feeding occurred in the evening.

Fox and coyote tracks were often observed in roost areas and at times they passed within 10 m of roosting birds during the night. Of the 372 winter roosts observed, there was no evidence that any birds were killed or flushed at night.

Only 5 % of all night roosts were in agricultural areas. Those that were observed were in corn fields and were either snow burrows or depressions in snow that had accumulated behind the rows or between taller stalks of picked corn. A number of roosts were located in unplowed lowlands in the middle of several corn fields. These areas were used early in the winter, but were abandoned once they filled with blowing snow, eliminating cover.

Vegetation roosts in early spring, were also dominated by lowland species, particularly Panicum (Table 7). The increase in agricultural use for night roosting in spring was due to the use of alfalfa. These alfalfa fields were used very little in winter as they provided little cover above the snow and snow was never deep enough to permit burrowing. The roosts observed during the heavy snow in early March were all snow burrows.

Effective Cover. Mean Robel pole total and vegetation coverage are presented in Table 7. Only two snow burrows had vegetation above the snow that providing the Robel pole readings and 99.9 % of the four coverage readings were snow. The use of snow as cover appears to serve primarily as wind shelter and/or insulation. Snow depressions had more vegetation cover, but snow still dominated coverage at 75 %. Even when not roosting in snow burrows or depressions, roosting prairie chickens make some use of snow for coverage as 8 % of the four coverage readings in vegetation-snow roosts were snow. Mean coverage by vegetation ranged from 1.1 to 3.8 and total coverage (including snow) varied between the types of night roosts (Table 7). Total coverage and vegetation coverage are higher in the winter than early spring. Analysis of 368 random points in the same habitat as the roosts suggests that prairie chickens when roosting select sites in winter with greater total and vegetation coverage and deeper snow. The selection of taller cover continues into the early spring (Table 7).

Height Class. Class III (25 to 50 cm) or taller residual vegetation was associated with 94.1 % of all roost types (Appendix Table 15). The lower classes were used, but were of limited importance. Comparisions with random height classifications, indicated that prairie chickens selected the taller classes within the areas they used. This difference is significant ($P < .001, df = 3$). A breakdown by disturbance types, shows that 78 % of observed roosts were in undisturbed habitat.

Of the birds using undisturbed habitat, 68 % selected unmowed lowlands. Uplands or mowed lowlands were not used in winter or early spring.

The information collected at the actual roost sites supported the telemetry data and showed that most prairie chickens in the winter of 1984-85, night roosted in the unmowed Class III lowlands. Shrubs, primarily snowberry were used during midwinter for night roosting, but only after the snow was deep enough to permit burrowing.

Night roosts were usually located in the open, away from tree(s). Mean distance to the nearest single tree in winter was 320 m, (SD = 221, N = 485) and to nearest trees (woodlot or clump) 353 m (SD = 241, N = 485). The range was 2 to 1000 m. The birds roosted farther from trees in spring than winter. (Mean = 503 m, SD = 354, N = 33 versus Mean = 353 m, SD = 241, N = 485). The birds roosted near the edge of cover in both winter (Mean = 18.1 m, SD = 0.5, N = 401) and spring (Mean = 14.7 m, SD = 10.4, N = 50). The nearest edge in both spring and winter was typically a lower height Class (91 %) and 83 % of the edge types were heavily grazed or mowed and contained no cover. Roosting flocks confined themselves to a small portion of a roost area as average maximum distance between roosting birds was 27.9 m (SD = 15.8, N = 94) in the winter and 11.5 m (SD = 27.4, N = 24) in the spring. The average distance to nearest bird shows the same pattern as birds roosted closer to each other in spring 0.7 m (SD = 0.6, N = 36) than in the winter, 1.0 m (SD = 1.7, N = 261). The

greater distances from the edge and between birds in winter was thought to be due to less cover above the snow, causing the birds to spread out over a larger area to find suitable cover or snow.

Size. Even though prairie chickens clustered when night roosting and remained near the edge, they roosted in relatively large undisturbed areas. The size of roost areas as determined by measurements from aerial photographs and in the field, showed that the mean size for 26 winter roost areas was 1.3 ha (3.8 acres) with a range of .04 to 5.5 ha (0.1 to 13. 6 acres); 76 % were greater than 0.4 ha (1 acre) in size. Average length was 174 (SD = 105) and width 88 m (SD = 38). The larger areas were associated with private land or rough areas in the SNG that were not or could not be mowed. The size of the areas used in spring were smaller with a mean of 0.4 ha (SD = .28, N = 7) (1 acre). Mean length and width were 82 (SD = 39) and 45.7 m (SD = 33).

Not all areas were measured as some were not distinct enough to accurately deliniate. Their inclusion would have made the means even larger. It is believed that larger areas were selected for winter night roosting because of the greater security provided in the form of cover above the snow. In early spring there is probably just as much cover available in a smaller area. The winter roost areas were all within 2.4 km of known feeding areas (Mean = 895 m, SD = 105, N = 26).

These roost areas were similar in type, height class and species composition when compared to areas used by radioed prairie chicken hens for nesting.

At least 9 of the areas used by prairie chickens for winter night roosting either were or had been used by radioed hens for nesting.

Thus the undisturbed lowland community on the SNG is the critical component for winter night roosting sites and nesting habitat. These are the two places where an individual spends more than a few hours in one spot. The amount and distribution of this lowland cover on the SNG is determined by lowland mowing practices, the pattern of which will be a key factor in maintaining or improving habitat for prairie chickens on the SNG. Nesting and roosting cover along with winter food should serve as focal points for any future management plans for the prairie chickens on the Sheyenne National Grasslands.

LITERATURE CITED

Ammann, G. A. 1944. Determining the age of pinnated and sharp-tailed grouse. J. Wildl. Manage. 8:170-171.

_____, 1957. The prairie grouse of Michigan. Michigan Dept. Conserv. Tech. Bull. 200pp.

American Ornithologist's Union. 1983. Check list of North American birds. 6th ed., A. O. U., Allen Press, Lawarence, Kansas, 877pp.

Armstrup, S. C. 1980. A radio collar for game birds. J. Wildl. Manage. 44 (1):214-216.

Avery, T. E. and G. L. Berlin. 1977. Interpretations of Aerial Photographs. 3rd ed. Burgess Publishing Co., Minneapolis, Minn. 260pp.

Baker, M. F. 1953. Prairie chickens of Kansas. Univ. of Kansas Mus. Natur. Hist. and Biol. Surv. of Kansas, Misc. Publ. 5. 68pp.

Burt, W. H. 1943. Territoriality and home range concepts applied to mammals. J. Mammal. 3:346-352.

Dumke, R. T., and C. M. Pils. 1973. Mortality of radio-tagged pheasants on the Waterloo wildlife area. Wis. Dept. Nat. Resour. Tech. Bull. 72. 52pp.

Drobney, R. O. and R. D. Sparrowe. 1977. Land use relationships and movements of greater prairie chickens in Missouri. Trans. Mo. Acad. Sci. 10-11:146-160.

Dakotas Planning Team. 1979. Sheyenne National Grassland, Land management plan background reports. U. S. Forest Service. Dickinson, N. D. 140pp.

Gleason, H. A., and A. Cronquist. 1963. Mannual of vascular plants of northeastern U.S. and adjacent Canada. Van Nostrand, Princeton, N.J.

Gower, W. C. 1939. The use of the bursa of Fabricus as an indication of age in game birds. Trans North Am. Wildl. Conf. 4:426-430.

Grange, W. B. 1948. Wisconsin grouse problems. Wis. Conserv. Dept., Madison. 318pp.

Gross, A. O. 1932. Progress report of the Wisconsin prairie chicken investigation. Wis. Conserv. Comm. Madison. 112pp.

Hamerstrom, F. N., Jr. and F. Hamerstrom. 1949. Daily and seasonal movements of prairie chickens. Auk 64:313-337.

_____, O. E. Matson, and F. Hamerstrom. 1957. A guide prairie chicken management. Wis. Conserv. Dept. Tech. Wildl. Bull. 15., Madison. 128pp.

_____, and F. Hamerstrom. 1973. The prairie chicken in Wisconsin. Wis. Dept. of Nat. Resour. Tech. Bull. 64., Madison. 55pp.

Hayne, D. W. 1949. Calculation of size of home range. J. Mammal. 30:1-18.

Heezen, K. L., and J. R. Tester. 1967. Evaluation of radio-tracking by triangulation with special reference to deer movements. J. Wildl. Manage. 31:124-141.

Honacki, J. H., K. E. Kinman, and J. W. Koeppl. 1982. Mammal species of the world. Allen Press Inc., Lawarence, Kansas. 694pp.

Horak, G. J. 1985. Kansas Prairie Chickens. Kansas Fish and Game Comm., Tech. Bull., Pratt, Kansas.

Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27:757-778.

Kirkpatrick, C. M. 1944. The bursa of Fabricius in ring-necked pheasants. J. Wildl. Manage. 8:118-129.

Lonner, T. N. and D. E. Burkhalter 983. Telday: A system for analyzing home range. Working draft. Res. Bur. Mont. Dept. Fish Wildl. & Parks, Bozeman. 13pp.

Manske, L. L. 1980. Habitat phenology and growth of selected sandhills range plants. PhD. Thesis, North Dakota State U., Fargo, N. D. 154pp.

_____ and Barker, W. T. 1981. Habitat use of prairie chickens Sheyenne Grasslands. North Dakota Acad. Sci. 36:2.

Mohler, L. L. 1963. Winter surveys of Nebraska prairie chickens and management implications. J. Wildl. Mange. 27:737-738.

Nie, N. H, C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Bent, editors. 1975. SPSS: Statistical package for the social sciences. 2nd ed. McGraw-Hill Book Co., New York, N. Y. 675pp.

Petrides, G. A. 1942. Age determination in American gallinaceous game birds. Trans. North. Am. Wildl. Conf. 7:308-328.

Robel, R. J., J. N. Briggs, J. J. Cebula, N. J. Silvy, C. E. Viers, and P. G. Watt. 1970a. Greater prairie chicken ranges, movements and habitat useage in Kansas. J. Wildl. Mange. 34:286-306.

_____ A. D. Dayton, and L. C. Hulbert. 1970b. Relationships between visual obstruction, measurements and weight of grassland vegetation. J. Range. Manage. 23:295-297.

Schwartz, C. A. 1945. The ecology of the prairie chicken in Missouri. Univ. Mo. Studies 20. 99pp.

Schmidt, F. J. W. 1936. Winter food of the sharp-tailed grouse and pinnated in Wisconsin. Wilson Bull. 48:186-203.

Yeatter, R. E. 1943. The prairie chicken in Illinois. Ill. Nat. Hist. Survey Bull. 22:377-416.

Wright, P. L. and R. W. Hiatt. 1943. Outer primaries as age determiners in gallinaceous birds. Auk 60:265-266.

Table 8. Individual home range sizes (sq km) for radio-tagged prairie chickens and sharptails during winter, (15 December - 17 February), Sheyenne National Grasslands, North Dakota, 1984-1985. Area in square miles in parentheses.

Prairie Chicken					Sharptail				
Bird No	Dates	N	Area	Gd*	Bird No	Date	N	Area	Gd*
Adult hens									
64	12-20-84 TO 2-17-85	310	13.6(5.2)	24/02	405	12-18-84 TO 2-17-85	49	7.0(2.7)	4/28
724	1-30-85 TO 2-17-84	54	3.4(1.3)	02					
100	1- 5-85 TO 2-17-85	136	6.5(2.5)	02					
618	12-12-85 TO 2-17-85	139	16.1(6.2)	16/25					
32	1- 3-85 TO 2-17-85	176	7.3(2.8)	02/51					
23	1-25-85 TO 2-17-85	97	4.3(1.7)	51					
71	1-25-85 TO 2-17-85	87	2.2(0.9)	51					
203	1-22-85 TO 2-17-85	64	2.7(1.0)	02					
1233	1- 5-85 TO 2-17-85	81	5.5(2.1)	02					
220	12-12-84 TO 2-17-85	24	3.1(1.2)	39					
83	1- 5-85 TO 2-15-85	89	8.7(3.4)	02					
120	2- 6-85 TO 2-17-85	43	1.8(0.7)	02					
Immature hens									
81	1-20-85 TO 2-17-85	170	9.4(3.6)	24	645	12-21-84 TO 2-17-85	194	12.4(4.8)	11/28
344	2- 2-85 TO 2-17-85	99	4.1(1.6)	02/24	333	12-21-84 TO 2-17-85	86	6.9(2.8)	11/46
443	1-20-85 TO 2-17-85	170	9.2(3.5)	24/02	204	12-27-84 TO 2-17-85	52	7.1(2.8)	28/04
Adult cocks									
421	12-16-84 TO 2-17-85	101	3.7(1.4)	25	433	1- 1-85 TO 2-17-85	131	3.8(1.5)	46
44	12-25-84 TO 2-17-85	147	6.7(2.67)	48	432	12-14-84 TO 2-17-85	143	2.4(0.9)	28
73	12-28-84 TO 2-17-85	218	11.5(4.4)	48/51					
733	12-26-84 TO 2-17-85	147	6.7(2.6)	48/51					
Immature cocks									
34	12-28-84 TO 2-17-85	186	9.8(3.8)	02/24	922	12-18-84 TO 2-17-85	210	3.5(1.4)	28
					101	12-18-84 TO 2-17-85	190	6.0(2.3)	28
					105	12-23-84 TO 2-17-85	212	6.4(2.4)	28

* Display ground(s) nearest winter range.

Table 9. Distance individual radio-tagged prairie chickens and sparptails moved (km) from winter range to spring areas (hens to nest and cocks to home booming ground), Sheyenne National Grasslands, 1984-1985. Distance in miles in parentheses.

	Prairie Chickens			Sharptails	
	Distance			Distance	
Bird No.	Maximum	Minimum	Bird No.	Maximum	Minimum
Adult hens					
64	4.5(2.8)	1.9(1.2)	405	3.5(2.2)	0.2(0.1)
100	8.5(5.3)	5.0(3.1)			
618	7.2(4.5)	0.3(0.2)			
32	10.9(6.8)	7.6(4.7)			
23	6.1(3.8)	2.4(1.5)			
71	3.5(2.2)	0.3(0.2)			
220	6.6(4.1)	4.7(2.9)			
120	7.7(4.8)	5.6(3.5)			
Immature hens					
81	8.5(5.3)	5.0(3.1)	645	4.7(2.9)	0.2(0.1)
344	5.6(3.5)	3.2(2.0)	333	8.4(5.2)	5.2(3.2)
443	4.0(2.5)	0.6(0.4)	204	6.8(4.2)	4.2(2.6)
Adult cocks					
421	2.5(1.6)	0.3(0.2)	433	2.7(1.7)	0.2(0.1)
44	4.3(2.7)	0.2(0.1)			
73	4.4(2.7)	0.2(0.1)			
733	4.5(2.8)	0.2(0.1)			
Immature cocks					
34	6.9(4.0)	0.6(0.4)	922	2.3(1.4)	0.5(0.3)
			101	2.6(1.6)	0.5(0.3)
			105	2.3(1.4)	0.5(0.3)

Table 10. Frequency of observed activity by habitat type (%) for radio-tagged and non-radioed prairie chickens during winter (15 December - 17 February), and early spring, (18 February - 15 March), Sheyenne National Grasslands, 1984-1985. Number of birds in parentheses.

Habitat Type	Winter Activity			Early Spring Activity		
	Feeding	Day Roost	Loafing	Feeding	Day Roost	Loafing
Agricultural	90.0(1272)	21.9(138)	76.1(823)	28.1 (36)	14.9 (36)	51.4(37)
Grass	5.7 (81)	33.1(209)	3.3 (36)	71.1 (91)	18.3 (51)	5.6 (4)
Shrubs	1.7 (24)	14.1 (89)	8.4 (91)	0.8 (1)	15.8 (44)	8.3 (6)
Edge Type	0	9.2 (58)	0.4 (4)	0	32.7 (91)	27.8(20)
Wetland	1.4 (20)	1.9 (12)	0.4 (4)	0	0	0
Trees and edge	1.1 (16)	19.8(125)	11.4(123)	0	23.2 (56)	6.9 (5)
Total	100.0(1413)	100.0(631)	100.0(1081)	100.0(128)	100.0(278)	100.0(72)

Table 11. Frequency of observed activity by vegetation height classes (%) for radio-tagged and non-radioed prairie chickens during winter (15 December - 17 February), and early spring, (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985. Number of birds in parentheses.

	Winter Activity			Early Spring Activity		
Vegetation Height Class	Feeding	Day Roost	Loafing	Feeding	Day Roost	Loafing
Class I (0 - 8 cm)	81.8(1044)	7.6 (41)	58.1(508)	81.9(127)	0	42.7(29)
Class II	17.9 (228)	23.8(129)	28.0(245)	17.4 (27)	21.6 (51)	47.1(32)
Class III (25 - 50 cm)	0.3 (4)	63.0(342)	4.3 (38)	0.6 (1)	65.3(154)	1.5 (1)
Class IV + (>50 cm)	0	5.7 (31)	9.5 (83)	0	13.1 (31)	8.8 (6)
Total	100.0(1276)	100.0(543)	100.0(874)	100.0(155)	100.0(236)	100.0(68)

Table 12. Occurrence of activity in various disturbance types (%) for radio-tagged and non-radioed prairie chickens in winter, (15 December to 17 February) and spring, (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985. Number of birds observed in parentheses.

	Winter					Early Spring				
	Activity					Activity				
Disturbance Type	Flying To	Feeding	Day Roost	Loafing	Budding	Flying To	Feeding	Day Roost	Loafing	Budding
Agricultural	95.3(264)	80.1(644)	13.1 (79)	54.9(542)	0	68.2 (30)	74.5(146)	1.1 (3)	6.1 (5)	0
Grazed	0	0.1 (1)	2.9 (17)	0.3 (3)	0	0	16.3 (32)	11.5 (32)	0	0
Mowed	2.9 (8)	19.5(157)	12.4 (75)	17.6(174)	0	0	2.0 (4)	13.6 (38)	41.3(26)	0
Total Disturbed	98.2(272)	99.7(802)	28.4(171)	72.8(719)	0	68.2 (30)	92.9(182)	28.3 (73)	37.8(31)	0
Edge Disturbed & Undisturbed	0	0	8.3 (50)	3.6 (36)	0	0	0	11.6 (30)	1.2 (1)	0
Undisturbed	1.4 (4)	0.1 (1)	47.3(282)	14.1(139)	0	31.8 (14)	0	47.7(123)	35.4(29)	0
Snowberry	0	0.1 (1)	8.5 (51)	0.1 (1)	33.3 (4)	0	0	12.4 (32)	0	0
Disturbed Total	1.4 (4)	0.2 (2)	55.2(333)	14.2(140)	0	31.8 (14)	7.1(14)	60.1(155)	35.4(29)	0
Trees	0.4 (1)	0	8.1 (49)	9.5 (94)	66.7 (12)		0	0	25.6(21)	100.0 (2)
Total	100.0(277)	100.0(804)	100.0(603)	100.0(989)	100.0 (16)	100.0 (44)	100.0(196)	100.0(258)	100.0(82)	100.0 (2)

Table 13. Use of public and private land by time of day (%) for radio-tagged prairie chickens, during winter (15 December - 17 February) and early spring (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985. Number of locations in parentheses.

	Winter					Early Spring				
	Time of Day					Time of Day				
Land Type	AM	Midday	PM	Night	Total	Total	AM	Midday	PM	Night
Private	93.2(580)	84.3(585)	78.7(355)	43.8(230)	76.4(1750)	77.8(1075)	94.1(301)	81.9(303)	89.2(309)	45.4(162)
Public (SNG)	6.8 (42)	15.7(109)	21.3 (96)	56.2(295)	23.6 (542)	22.2 (307)	5.9 (19)	18.1 (67)	7.8 (26)	54.6(195)
Total	100.0(622)	100.0(694)	100.0(451)	100.0(525)	100.0(2292)	100.0(1382)	100.0(320)	100.0(370)	100.0(335)	100.0(357)

Table 14. Percent occurrence of dominant plant species at prairie chicken night roosts, winter (15 December - 17 February) and early spring (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985. Number of roosts in parentheses.

	Winter					Early Spring
	Type of Roost					Type of Roost
Species	Vegetation	Vegetation and Snow	Snow Burrow	Snow Depression	Total	Vegetation
Panicum vergatum	7.7 (3)	9.2(10)	2.6 (4)	5.5 (7)	5.6 (24)	9.5 (6)
Panicum spp.	12.8 (5)	2.8 (3)	13.6(21)	15.7(20)	11.4 (49)	
Carex lanuginosa	12.8 (5)	3.7 (4)	3.8 (6)	3.1 (4)	4.4 (19)	30.2 (19)
Carex spp.		36.7(40)		13.3(17)	13.3 (57)	9.5 (6)
Panicum/Carex spp.	7.7 (3)	29.4(32)	2.6 (4)	3.9 (5)	10.2 (44)	9.5 (6)
Andropyron repens		3.7 (4)	7.1(11)	10.2(13)	6.5 (28)	7.9 (5)
Phalaris arundinacea	51.3(20)	1.8 (2)		2.4 (3)	5.8 (25)	
Calamagrostis inexpansa	2.6 (1)	3.7 (4)			0.9 (5)	1.6 (1)
Bromus inermis			0.6 (1)	1.6 (2)	0.7 (3)	
Andropogon gerardi						9.5 (6)
Spartina gracilis		6.4 (7)		1.6 (2)	2.1 (9)	
Andropogon scoparius			11.0(17)	5.5 (7)	5.6 (24)	
Melilotus spp.			14.9(23)	7.1 (9)	7.5 (32)	
Symphoricarpos occidentalis			19.5(30)	13.4(17)	11.0 (47)	
Salix spp.	2.6 (1)		4.5 (7)		1.9 (8)	1.6 (1)
Aster sp.			5.8 (9)	1.6 (2)	2.6 (11)	
Solidago spp.			2.6 (4)	1.6 (2)	1.4 (6)	1.6 (1)
Typha sp.				0.8 (1)	0.2 (1)	
Poa sp.	0.6 (1)				0.5 (2)	
Sorghastrum nutans			5.8 (9)	2.4 (3)	2.8 (12)	
Corn		2.8 (3)	1.9 (3)	.8 (1)	1.6 (7)	
Alfalfa				9.5(12)	2.8 (12)	19.0 (12)
Open snow					3.2 (5)	
Total	39	109	150	134	437	63

Table 15. Use of vegetation height classes (%) for observed prairie chicken night roosts and random points during winter, (15 December - 17 February), and early spring (18 February - 15 March), Sheyenne National Grasslands, North Dakota, 1984-1985.

	Vegetation Height Class			
	I	II	III	IV+
Roost Type	0-8 cm	9-25 cm	26-50 cm	>50 cm
Vegetation				
Winter	0	8.8 (3)	76.5 (26)	14.7 (3)
Spring	2.1 (1)	29.2(14)	66.7 (32)	2.1 (1)
Vegetation and snow				
Winter	0	4.7 (5)	77.4 (82)	17.9(19)
Spring	0	0	100.0 (6)	
Snow Depression	.9 (9)	.9 (1)	79.1 (91)	19.1(22)
Unused Snow Depression	1.3 (1)	0	82.5 (66)	16.3(13)
Snow Burrow	2.3 (3)	.8 (1)	73.1 (95)	23.8(31)
Unsuccessful Snow Burrow	0	2.2 (1)	62.2 (28)	35.6(16)
Total winter	3.3(13)	2.6(10)	75.0(294)	19.1(75)
Total spring	3.9 (2)	13.7(17)	80.4 (41)	2.0 (1)
Random Points				
Winter	7.9(12)	23.7(36)	47.4 (72)	21.1(32)
Spring	32.3(32)	26.3(26)	37.4 (37)	4.0 (4)